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BULLETIN No. 34.

COUNTY OF NORTHUMBERLAND.

EDUCATION COMMITTEE.

COUNTY AGRICULTURAL EXPERIMENT STATION, COCKLE PARK.

Guide to Experiments for 1922.

REPORT BY

PROFESSOR DOUGLAS A. GILCHRIST, M.Sc.,

DIRECTOR ON BEHALF OF ARMSTRONG COLLEGE, NEWCASTLE-UPON-TYNE.

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Reports are issued from time to time on the results of the various experiments. Agriculturists resident in Northumberland can obtain these on application to the Director of Education, The Moothall, Newcastle-upon-Tyne.

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Note.

Cockle Park is within 4½ miles from Morpeth (fast trains), and 3½ miles from Longhirst (slow trains) on the North-Eastern Railway.

Conveyances for parties—numbering five and upwards—can be hired at the rate of 2/6 each person for the journey, from *Morpeth* Station, to Cockle Park and back to Morpeth, at the following livery stable:—Whittle Brothers, Morpeth.

Arrangements for Parties. The Farm Steward (Cockle Park, Morpeth) can provide dinner (2/6 per head), and tea (1/6 per head) for parties not exceeding 60 in number. *In each case 7 days' notice must be given to the Farm Steward.* Liquors cannot be supplied at the Station.

Persons or parties desiring to visit Cockle Park are invited to communicate *at least a fortnight beforehand* with the *Director of Education, The Moothall, Newcastle-upon-Tyne.*

GENERAL CHARACTER OF WORK.

Cockle Park has been the Northumberland County Experiment Station since 1897. The farm buildings have been made suitable for the conduct of feeding and other experiments with cattle and sheep, and breeding experiments are made with these animals. The large area of what was very poor pasture, lying chiefly on poor stiff boulder clay, has proved to be excellent for investigations on how to improve poor pasture and meadow land lying on such a soil, while there is sufficient of the same on poor sandy soils to show that distinctly different manurial treatment from the foregoing is needed on these latter soils.

The following figures give the acreages of the chief farm crops in Northumberland for 1914 and 1921.

	1914. Acres.	1921. Acres.		1914. Acres.	1921. Acres.
Permanent pasture ...	429,844	391,161	Beans	1,037	1,492
Old land hay	88,699	80,501	Peas	182	337
Rotation hay	37,051	44,316	Turnips and swedes ...	32,779	29,768
Rotation pasture ...	24,455	24,638	Potatoes	5,796	5,622
Wheat	6,655	8,696	Cabbages	533	484
Barley	29,271	30,573	Mangels	476	582
Oats	39,167	42,858	Bare fallow	1,912	3,458

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On the great bulk of poor pastures on the heavy soils of Northumberland, basic slag is the most effective manure for economic improvement, and on the lighter soils the same manure, along with a potash manure, has also been found to be most effective. The question has also been settled that second and even up to sixth dressings of slag are quite as effective as first dressings. The after-effects of feeding cake to grazing stock have not proved as satisfactory as was expected.

For old land hay active nitrogenous manures have been shown to deteriorate greatly the feeding value of the hay, while phosphatic manures, combined with potash manures if necessary, have greatly developed clover and improved the feeding value of the hay. In combination with dung, slag has been found to be the best artificial dressing for old land hay, probably because the dung contains sufficient nitrogen and potash, while slag supplies phosphates and lime in sufficient quantities and in a suitable condition to act with dung.

The improvement in the hay and pasture at Cockle Park, especially in the quality of both, has enabled a much larger stock to be kept with considerably less expenditure on concentrated feeding stuffs. The better feeding quality of the hay has reduced the amount of cake and meal needed in the winter, and the better feeding quality of the pasture, especially of the winter foggage, has enabled the grazing stock to depend to a much greater extent on the pasture.

The trials of varieties of oats and barleys have demonstrated which of these are the most suitable for different conditions in Northumberland, and some work has also been done with varieties of wheat and beans. The composition of swedes and turnips has been fully investigated; the effects of variety, season, and manuring are all taken into account, the season factor being found to give the greatest variation. Some work has been done with mangels, and it has been fully demonstrated that mangels are considerably poorer in quality and produce smaller crops when they are grown under the climatic conditions of Northumberland, than when grown in most other English counties. The full investigations made on grasses, clovers and seeds mixtures have resulted in seeds mixtures being evolved which, after proving a success at Cockle Park, have been adopted all over the country. The introduction of wild white clover has been a leading feature. The work in connection with rotations of crops has shown conclusively the advantages of longer leys and of systematically manuring for the benefit not of one crop but for those of the whole rotation.

The results of all these are dealt with under their various headings in this guide and more fully in the published reports and bulletins.

The feeding experiments with cattle and sheep made in the cattle boxes and in the sheephouse (both specially designed for experimental work) are conducted with a view to ascertaining the comparative feeding values of the principal cakes and other foods in use by farmers, and of foods that would probably be used by farmers if their feeding qualities were known. These foodstuffs are always analysed, so that the fullest information may be obtained as to their feeding and manurial values. Bulletins issued contain, in addition to the results of feeding experiments with cattle and sheep, suggestions as to suitable daily rations for fattening cattle and for milch cows.

The conduct of these investigations involves annually a large number of analyses of samples of soils, manures, foods and other material, which are carried out in Armstrong College by Mr. S. H. Collins, M.Sc., Adviser in Agricultural Chemistry. Mr. H. C. Pawson and Mr. C. C. Worters, P.A.S.I., have given most valuable help in tabulating the results.

LAND AND LIVE STOCK.

Land.—This extends to about 460 acres, of which there are about 100 acres under rotation crops, 50 acres meadow hay, 293 acres pasture and 20 acres plantations. The bulk of the land (about 363 acres) on the west and north west, as well as on the eastern corner, is heavy clay of a poor character, lying on the worst type of Boulder Clay. Around the Tower the soil is mostly a useful loam (about 31 acres) on a mixed Boulder Clay and sandstone subsoil. The soil on the eastern halves of the Back House and Davy Houses Fields, as well as the north of Broomy Hill and almost the whole of East Tower Hill, is a light sandy loam (about 54 acres) lying direct on sandstone of the Millstone Grit, which is also the underlying rock of the Boulder Clay throughout the whole area. A peaty and alluvial sandy loam (about 13½ acres) is found in the Back Butts Field and along the hollow running south from the bottom of the rotation plots. The Tower stands 326 feet above sea level, and on the average the land is about 300 feet above sea level. The 400 acres at Cockle Park were taken on a 21 years' lease from 1896. A similar lease was renewed from 1917, with the addition of 60 acres of poor pasture land on Paradise Farm. The land is owned by the Duke of Portland.

The total area of land in Northumberland is 1,284,189 acres, of which 668,987 acres are under crops and grass (not including mountain and moorland pasture). Of this over 400,000 acres lie on Boulder Clay, so that Cockle Park well represents the county so far as the soils on this clay are concerned. The sandy soils on the Millstone Grit represent very large areas of similar soils throughout the county lying on sandstone rocks of the Mountain Limestone, of the Millstone Grit and of other formations, and on the Glacial Sands and Gravels.

Cattle.—There are 25 Galloway cows, from which blue grey calves are bred by the use of a white shorthorn bull. A few shorthorn (Irish) cows are also crossed with a Galloway bull so that Shorthorn—Galloway and the Galloway—Shorthorn crosses may be compared. The calves are always polled and are usually blue-grey in colour. The calves of the latter cross are the best growers. This may be due to their dams being the best milkers. The cows are on pasture all the year round, and are never indoors nor in a shelter shed. The Galloway cows do remarkably well under this treatment. The cows suckle their calves, and calving commences early in April, as it is found the calves make the best progress when calving is delayed till the spring herbage of the pasture developes. As a rule each cow receives daily about 8 lb. of meadow hay for four months, or about 8½ cwt. per cow each winter. The value of the pasturage of each cow and her calf is estimated at about £5 a year, with, in addition, about 34s. for hay (at £4 a ton). The average cost per cow of the year's feeding is about £6 14s. 0d., to which has to be added the value of the calf at birth (about 60s.), which meets the incidental expenses connected with breeding. The calves dropped in April and May have therefore cost about £9 14s. 0d. by the end of October, when they are weaned. For the average of the three years ending October 31st, 1918, the calves had an estimated value of £11 10s. 0d. when weaned (live weight about 430 lb.); and have been valued on March 31st following at about £17 each (live weight about 500 lb.) They have been sold as good stores about September 30th, thereafter, when about seventeen months old, at the end of the grazing season, at about £25 each (live weight about 770 lb.)

A few milch cows are kept, and about forty calves in all were reared in 1921.

Last winter nineteen of the previous summer's blue grey calves were again wintered with good results in Broomy Hill pasture field where they had free entry to and exit from a shelter shed open to the south.

It has been found that shorthorn cows are, as a rule, not hardy enough to stand outdoor treatment in winter similar to that suitable for Galloway cows. If, however, shorthorn cows had access to a shelter shed during the worst part of the winter, and had a moderate amount of hand feeding, the results would probably be very satisfactory.

Sheep.—There are 90 half-bred and mule ewes kept as a breeding flock. They are crossed with Oxford Down and Suffolk rams. All the lambs are fattened, mostly on the wild white clover aftermaths. In previous years half-bred rams were also used, and the lambs kept for the experiments in Tree Field. Border Leicester rams were compared with the Oxford Down rams for some years. On half-bred ewes, the Oxford Down ram gave slightly better results than the Border Leicester ram so far as fat lambs were concerned; but on similar ewes the Border Leicester ram was distinctly superior to the Oxford Down when the lambs were kept till they were shearlings. The Oxford Down on half-bred ewes has produced rather better lambs than the Suffolk ram, but on mule ewes the Suffolk has given the best results.

Time of applying manures.—For hay and pasture, basic slag, superphosphate, bone meal, dissolved bones, fish meal, and the potash manures are all applied in the previous November. Active nitrogenous manures are applied in spring. When artificials are applied to roots, they are all applied in the drills in spring, except nitrate of soda and nitrate of lime, which are applied as topdressings later. Dung is applied in the drills in spring to roots and potatoes and in the previous autumn to old land hay.

Particulars of manures used in the experiments.—In the following list the prices are all per ton:—Nitrate of soda, 15·5 % nitrogen, £18 0s. 0d.; sulphate of ammonia, 20 % nitrogen, £16; basic slag, 39 % phosphate of lime, £3 18s. 0d.; dissolved bones, £9 0s. 0d.; English bone meal, £9 0s. 0d.; precipitated bone phosphate, 80 % phosphate of lime, £8 10s. 0d.; fish meal, £11; kainit, 12 % potash, £3 12s. 0d.; muriate of potash, 50 % potash, £13 15s. 0d.; sulphate of potash, 50 % potash, £16 5s. 0d.; crude potash salts, 30 % potash, £5 5s. 0d.; common salt, £2; lime shells, 14s.; ground lime, £1 4s. 0d.; ground limestone, £1 4s. 0d.; lime mud, 6s. 0d.; gas lime, 5s. 0d.; farmyard manure, 7s. 6d.

N.B.—The prices given above are the same as in Guide for 1918.

MANURES FOR PASTURE IN TREE FIELD.

This field extends to about 34 acres and is divided into 11 plots, which are each 3$\frac{1}{20}$th acres in area; $\frac{1}{20}$th acre of each was fenced off in former years and mown, but this was discontinued in 1919.

Bulletin No. 8 contains a complete report on the results of these experiments for the nine years 1897-1905, the first period for which Dr. Somerville's original scheme was carried out. The Guide for 1919 contains a full report for the second period of six years, 1906-11, and that of 1921 contains the same for the third period of six years, 1912-17.

The soil of this field is poor and stiff, lying on boulder clay Particulars of this, and of how the increases in live weights of the sheep are valued, are given in the Guide for 1921.

Fourth Period, 1918-23.—The scheme for the six years, 1918-23, given in the table below, is the same as the last, except that 300 lbs. of decorticated earth-nut cake are fed annually to the sheep on Plot 1 during the first three years instead of 600 lbs.; and that superphosphate is again applied in 1918 to Plot 5, instead of basic slag. The cake is fed in small quantities at first and gradually increased as the season advances.

The sheep, which are half-bred hoggs, are weighed when they are put on the plots, at the end of seven weeks, and when they are taken off. Their average value (deducting wool) when put on the plots was 66/6 a head this season.

Manures for Pasture in Tree Field.

Results per acre for four years (1918-21) under Fourth Scheme.
Plots 3$\frac{1}{20}$ acres in area.

Plot.	Treatment.	Cost of treatment. (6 years).	Fourth year, 1921.	Average of four years, 1918-21.		
			Live weight increase of sheep over plot 6.	Live weight increase of sheep over plot 6. †		Average annual gain. *
				Amount.	Value at 4½d. a lb.	
		S. D.	LB.	LB.	S.D.	S. D.
1	300 lb. dec. earth-nut cake fed to sheep annually till 1920	144/8	19¾	**88**	33/-	**8/11**
2a	Basic slag, 5 cwt., 1918 (applied July, 1917) and again 1921	39/-	55¾	**86**	32/3	**25/10**
2b	Basic slag, 5 cwt., 1918 (applied Nov., 1917) and again 1921	39/-	25½	**86¼**	32/4	**25/10**
3	Basic slag, 10 cwt., 1918	39/-	50¾	**91¾**	34/5	**27/11**
4	Basic slag, 5 cwt., 1918, repeated 1921	39/-	23½	**78**	29/3	**22/9**
5	Superphosphate, 7½ cwt., 1918, repeated 1921	63/2	47½	**75**	28/2	**17/8**
6	No treatment	—	—	—	—	—
7	Slag as on plot 4; 100 lb. mur. potash, 1918, repeated 1921	63/7	33½	**65**	24/5	**13/10**
8	Slag as on plot 4; 1 ton common lime, 1918, repeated 1921	67/-	35¼	**65½**	24/6	**13/4**
9	Slag as on plot 4; 112 lb. nitrate of soda, 1918, repeated 1921	75/-	26¼	**49½**	18/5	**5/11**
10	Diss. bones, 609 lb., 1918, repeated 1921	97/-	29½	**47½**	17/10	**1/8**

* This does not take into account the unexhausted residues of the first twenty-one years.

† The average value of live weight increase on plot 6 for four years 1918-21 was 13/1 (average increase in live weight = 35 lb.).

Number of sheep per plot.

Plots ...	1	2a	2b	3	4	5	6	7	8	9	1
1918 ...	11	10		9	10	10	4	9	9	8	8
1919 ...	10	10		12	10	10	4	9	9	8	8
1920 ...	10	10		11	10	10	4	9	9	8	8
1921 ...	7	10		11	10	10	4	9	9	8	8
1922 ...	7	10		11	10	10	4	9	9	8	8

Grazing periods (14 weeks).

1918	April 27th—August 2nd.
1919	May 8th—August 14th.
1920	May 8th—August 14th.
1921	May 14th—August 20th.
1922	May 19th—August 25th.

Live weight increases of sheep per acre.

Plots ...	1	2a	2b	3	4	5	6	7	8	9	10
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
1918 ...	143	131	132	113	127	111	31	109	98	108	97
1919 ...	110	131	148	131	105	116	32	88	95	64	72
1920 ...	169	147	159	191	158	149	54	148	151	119	115
1921 ...	44	80	50	75	48	72	24	58	60	50	53

Live weight gains per sheep per week during the season.

Plots	1	2a	2b	3	4	5	6	7	8	9	10
1918	2·79	2·80	2·83	2·70	2·73	2·37	1·30	2·59	2·33	2·88	2·60
1919	2·36	2·80	3·17	2·34	2·26	2·48	1·36	2·10	2·27	1·70	1·93
1920	3·67	3·20	3·46	3·79	3·44	3·25	2·95	3·58	3·67	3·24	3·13
1921	1·37	1·74	1·09	1·49	1·04	1·57	1·30	1·40	1·44	1·38	1·46

Winter and extra grazing (per acre) on Tree Field.—The plots are grazed in winter by the Galloway cows. A cattle week is the grazing of one beast for a week, and is valued at 1/-

Plots	1	2	3	4	5	6	7	8	9	10
				Cattle weeks,						
1918–19	6	9	9	9	9	5	9	9	9	9
1919–20	8	8	8	8	8	8	8	8	8	8
1920–21	4	8	8	8	8	2	5	8	5	5
1921–22	6½	8	8	8	7½	3½	8	9	8½	8½

Basic slag has given the best results on Tree Field. On plot 4, 5 cwt. an acre has been applied every third year and basic slag has kept its position up till the eighth dressing for 1918. Neither a potash manure nor lime have added to the effects of slag. The nitrogenous manures, sulphate of ammonia and nitrate of soda, when added to slag, have seriously checked the improvement of the pasture. The feeding of cake on plot 1 has given poor results. The results are stated more fully in the Guide for 1921.

Effects of Manures and of Cake Feeding on Hanging Leaves Pasture Fields.

These fields extend to fifty-seven acres. Up till 1898 they were pasture of a poor character, worth only a few shillings an acre. The soil is a poor clay and clay loam throughout, only about six inches deep on the average, and is lying on a subsoil of poor yellow boulder clay. In 1898 the fields were dressed with basic slag, the west field receiving 7½ cwt. and the east field 5 cwt., both per acre. The east field was pipe drained in 1897, and the west field was then surface drained between the ridges.

These experiments were originated by Sir Thomas Middleton with the object of comparing, on larger plots, the results of grazing with a mixed stock of cattle and sheep with those of sheep alone, as on Tree Field, and of ascertaining whether more effective improvement of pasture could be obtained by certain other means than by basic slag.

In 1902 four plots, each 10$\frac{1}{10}$th acres in area were fenced off across these two fields, and have been treated per acre as follows:—

Manures and cake used (per acre), 1903-21.

Plot 1.—10 cwt. basic slag (39 % phosphates) for 1903; 5 cwt. basic slag for 1906, and for every third year thereafter.

Plot 2.—Basic slag as for Plot 1; 3 cwt. Indian cotton cake* fed annually from 1904.

Plot 3.—10 cwt. basic slag for 1903; no further slag, but cake as for plot 2.

Plot 4.—10 cwt. basic slag for 1903; 4 cwt. basic slag and 3½ cwt. fish meal for 1906, and for every third year thereafter. The slag and fish meal contain the same nitrogen and phosphoric acid as is applied in the slag and cake for plot 2.

Live-weight increases (per acre) 1918-21.

	Plot 1.		Plot 2.		Plot 3.		Plot 4.	
	Cattle. lb.	Sheep. lb.	Cattle. lb.	Sheep. lb.	Cattle. lb.	Sheep. lb.	Cattle. lb.	Sheep. lb.
Averages of 1918–20 (3 years)	163	66	196½	73½	112	46½	112½	67
Results for 1921	100	52	132	57	74	35	98½	43

Value of increases per acre (cattle 4d., sheep 4½d., a lb.)

	Plot 1. s. d.	Plot 2. s. d.	Plot 3. s. d.	Plot 4. s. d.
Average of 3 years, 1918–20	79/1	93/1	54/9	62/8
Less annual cost of manures and cake ...	6/6	47/-	40/6	17/9
***Average annual gain**	**58/8**	**32/2**	**4d.**	**31/-**

* Deducting average annual cost of treatment plus average annual feeding value (13/1 an acre) of plot 6, Tree Field, which compares with the original condition of Hanging Leaves Fields.

The results and the values of increases for previous years are given in the Guide for 1921.

Results.—Basic slag is evidently a most effective manure for improving poor pasture of this description. This supplies phosphates and lime, both of which are deficient in this clay soil. A potash manure is not needed, as such a soil is likely to have a requisite supply of available potash, especially under pasture conditions. The soil was distinctly deficient in nitrogen. This is abundantly collected by the roots of clover and other leguminous herbage which are developed by slag. This is evidently the reason that neither the nitrogen of the Indian cotton cake nor of the fish meal are giving anything like effective returns. The greatly increased cost of cake has considerably reduced the nett gains on the plots on which cake is fed.

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*A small quantity of cake is fed at first, and is gradually increased as the season advances.

For each shilling spent on treatment in these fields in 1918-20, *plot* 1 *returns about* 9*s.* 0*d.*, *plot* 2 *about* 9d., *plot* 3 *no return, and plot* 4 *about* 1*s.* 9*d. The outlay on plot* 1 *varied from about one-third to about one-sixth of that on the other plots, while this plot gives considerably the greatest nett gain.*

Stocking of Plots.—The grazing period extended till 1911 to sixteen weeks each summer, but has been reduced to fourteen weeks since that time. The plots are stocked with cattle and sheep so as to give the pasture a better chance of improving than when stocked with sheep alone, as in Tree Field. The cattle are usually the previous season's blue grey calves, and the ewes are mainly half-bred.

Number of Cattle and Sheep per plot.

	Plot 1.			Plot 2.			Plot 3.			Plot 4.		
	Cattle.	Ewes.	Lambs.	Cattle.	Ewes.	Lambs.	Cattle.	Ewes.	Lambs.	Cattle.	Ewes.	Lambs.
1920 ...	9	6	12	10	6	12	6	4	8	7	6	12
1921 ...	9	6	12	10	6	12	6	4	8	7	5	10
1922 ...	9	6	12	10	6	12	6	4	8	7	5	10

For stocking in previous years see Guide for 1921.

The grazing period in 1921 extended from May 18th till August 24th, and in 1922 is the same.

Winter and extra grazing (per acre) on Hanging Leaves Fields.

	Cattle weeks.				Sheep weeks.				Value of winter grazing.*							
									s.	d.	s.	d.	s.	d.	s.	d.
Plots.	1	2	3	4	1	2	3	4	1		2		3		4	
1921-22.	$2\frac{4}{7}$	$1\frac{5}{7}$	$1\frac{5}{7}$	$2\frac{1}{7}$	$19\frac{5}{7}$	21	$15\frac{6}{7}$	$19\frac{5}{7}$	5	10	5	2	4	4	5	5
Average value (from 1904-5) ...									**6**	**5**	**6**	**1**	**5**	**7**	**5**	**11**

* This is based on each cattle week (the grazing of one beast per week) being worth 1/-; 6 sheep are taken as being equivalent to 1 cow.

Results with lime.—The question arises as to whether a dressing of lime would be a good addition to basic slag on this land. In January, 1907, cross dressings of lime were applied across the four plots, one ridge being dressed with 2 tons of lime and another ridge with 4 tons of lime mud, both per acre. Some improvement is now evident where these lime dressings have been applied. The addition of a small dressing of lime to slag on Tree Field has not proved profitable during the past ten years, but has slightly increased the live-weight gains of the sheep. On Tree Field lime alone on this poor clay pasture was not effective.

Grazing with cattle and sheep, and with sheep alone.—In the Tree Field experiment the plots are so arranged that they can be grazed with sheep only. In Hanging Leaves Fields the plots are more than three times larger than those in Tree Field, and are grazed regularly with a mixed stock of cattle and sheep. It is interesting to compare the results in the two fields, especially as the original conditions of the pasture, as well as the characters of the soil, are practically identical. Plot 4 of Tree Field and Plot 1 of the Hanging Leaves Fields have each received slag alone since 1897, in the same quantities, and at about the same dates of application. In each case the last dressings of slag applied were 5 cwt. an acre respectively for 1906, 1909, 1912, 1915, and 1918. For 1920 the live-weight gain of the sheep per acre on plot 4 of Tree Field was 158 lb., while on plot 1 of the Hanging Leaves Fields the live-weight gain of cattle and sheep per acre was 264 lb. For the twelve years, 1909-20, the average annual gains were 105¾ lb. on the Tree Field plot, and 198¼ lb. on the Hanging Leaves Fields plot. When the live-weight gains of all the plots on Tree Field are compared with those on the Hanging Leaves Fields they are found to be considerably greater in the latter case. The grazing season now extends to fourteen weeks in both fields.

DRAINAGE AND MANURIAL TRIALS IN NORTH FIELD, PARADISE.

This field extends to about 17½ acres and was very poor, wet and undrained pasture lying on boulder clay. Here trials are being made of the effects of pipe draining and mole draining, and of various phosphatic manures and lime. The phosphatic manures and lime were applied in February, 1922. All the phosphatic dressings contained 200 lbs. phosphoric acid per acre; the pipe draining was done in March, 1921, 2½ inch pipes being used for the minor drains and 3 inch pipes for the short main drains; the mole draining will probably be done in 1922. The phosphatic manures will be applied every third year, but only in half the quantities after the first dressing. Section I. begins at the west side of the field; the riggs are about 12 feet wide in this section, and about 11 feet wide in the other sections.

Section 1.

(1) 6 riggs (clear of two rigg headland). Unmanured.

(2) 6 riggs. Basic slag, 10 cwt. an acre, 38°/₀ phosphates.

(3) 6 riggs. Pipe drained every second furrow, middle drain 30 inches deep, and other two 24 inches deep. 3 riggs to west unmanured. Next three riggs 10 cwt. an acre basic slag, 38% phosphates.

(4) 6 riggs. Mole drained every second furrow, 20 inches deep. Basic slag on three east riggs as for plot 3.

(5) 6 riggs. Mole drained every furrow, 20 inches deep. Basic slag on three east riggs as for plot 3.

Section 2.

This section mole drained 20 inches deep every second furrow throughout, except south ends of 10, 11 and 12.

(6) 4 riggs. Basic slag, 9 cwt. an acre, 42% phosphates, citric solubility, 80°/o.

(7) 4 riggs. Basic slag, 17¼ cwt. an acre, 22°/o phosphates, citric solubility, 36°/o.

(8) 4 riggs. Nauru phospate, 4½ cwt. an acre, 84°/o phosphates.

(9) 4 riggs. Unmanured.

(10) 4 riggs. North African phosphate, 6 cwt. an acre, 63°/o phosphates, fineness of grinding 83°/o with 120 sieve (92°/o fineness with 100 sieve).

(11) 4 riggs. North African phosphate, 6 cwt. an acre, 63°/o phosphates, fineness of grinding 79°/o with 100 sieve (65°/o with 120 sieve).

(12) 4 riggs. American phosphate, 5⅓ cwt. an acre, 72°/o phosphates, fineness of grinding 93°/o with 100 sieve (81°/o fineness with 120 sieve).

Across plots 6 to 12 the following cross dressings on plots each one-third acre in area have been applied :—

Cross plot 1 (to north). No extra treatment.

Cross plot 2. Ground lime, 2 tons an acre.

Cross plot 3. Lime mud, 5 tons an acre.

These cross plots will be fenced off later and treated as hay plots. Eight yards to the south of these are similar cross plots in the same order, each one-sixth acre in area. These latter will not be fenced off, so that the effects of the lime treatment may be noted both when grazed and in hay.

Section 3.

This is about 2 acres in area, and consists of 12 riggs, each 11 feet wide. It is treated throughout with 5⅓ cwt. an acre of American phosphate, 72°/o phosphates, fineness of grinding 80°/o with 120 sieve ; and is mole drained 20 inches deep every furrow, except a part at the south end.

Section 4.

This is about ¾ acre in area, and has not been drained, but treated with American phosphate as for Section 3.

The north, west and south headlands have received 10 cwt. an acre of basic slag (39°/o phosphates).

Comparative costs of Phosphatic Manures, December, 1921.

Manure.	Phosphates.	Price per ton (including carriage).	Price per Unit.	Quantities per acre (200 lb. phosphoric acid).	Cost per Acre.
	°/o	s. d.	s. d.	Cwt.	s. d.
Basic slag	42	130/6	3/1½	9	58/9
Basic slag	38	122/6	3/2½	10	61/3
Basic slag	22	65/-	2/11½	17¼	56/1
American phosphate	72	130/-	1/10	5⅓	34/8
North African phosphate	63	127/6	2/-	6	38/3
Nauru phosphate ...	84	208/-	2/6	4½	46/10

The ground lime cost 46/9, and the lime mud 9/-, both per ton.

The costs of the dressings (per acre) were :—2 tons ground lime, 93/6 ; 5 tons lime mud, 45/-.

Davy Houses Field.—At the N.E. corner, 6 plots, each $\frac{1}{20}$th acre in area, were manured as follows in January, 1903 (per acre):—plot 1, (to the north) no manure; plot 2, 10 cwt. slag (200 lb. phosphoric acid); plot 3, 2 cwt. muriate of potash (100 lb. potash); plot 4, 10 cwt. slag and 2 cwt. muriate of potash; plot 5, 295 lb. superphosphate (36%, 50 lb. phos. acid); plot 6, 365 lb. superphosphate (29%, 50 lb. phos. acid).

For 1906, 1909, 1912, 1915, 1918, and 1921, the following manures per acre have been applied:—plot 2, 5 cwt. slag; plot 3, 200 lb. muriate of potash; plot 4, 5 cwt. slag and 200 lb. muriate of potash. In November, 1919, plot 5 received 354 lb. superphosphate (30%, 50 lb. phos. acid).

Results.—This is old pasture, very thick and matty, and lies on a light, sandy soil on Millstone Grit sandstone. The phosphatic manures are useful, slag doing considerably the best of these, but the potash manure alone is not effective; the combination of slag and a potash manure, however, on plot 4 has greatly developed clover on this matty pasture, while the herbage here has become fine and sweet, and is closely grazed by the stock. On this light soil slag effects a material improvement, even without the aid of a potash manure, which may be due to the lime it contains releasing potash from the large amount of organic matter contained at the surface of this soil. This result is of the greatest importance as showing that the good effects of slag on pasture are not confined to clay soils.

Basic slag versus bone meal. (Davy Houses).—Two plots, each one acre in area, have been marked off in this field. These run east and west on the north side of the field, and have a clay loam soil with a stiff boulder clay subsoil on their western halves, and a light sandy soil and subsoil on their eastern halves. Plot 1 (to the north) received 10 cwt. basic slag (200 lb. phos. acid), and plot 2, 8¾ cwt. bone meal (200 lb. phos. acid) in March, 1908. These dressings were repeated on the inside halves of each plot in December, 1910, December, 1916, and December, 1919, and on the other halves only half of these dressings were applied. Strips 17½ yards wide at each end of the plots ($\frac{1}{10}$th acre in area) were dressed in March, 1908, in December, 1913, in December, 1916, and in December, 1919, with 2 cwt. per acre of muriate of potash (110 lb. potash per acre.) A narrow strip all round the plots is left untreated. The objects are to compare the effects of basic slag and bone meal on the two classes of soil, in both cases with a poor, coarse, matted turf; and to test the addition of a potash manure to each of these on a heavy and on a light soil. The results are noted by observation of the character of the pasture, and it is evident that slag has proved considerably more effective than bone meal, both on the light and on the heavy soils.

Back Butts Field.—Seven plots, each $\frac{1}{10}$th acre in area, have been marked off in this field. The object is to compare the effects of various forms of lime on an old pasture. The soil is a black, sandy loam, resting on a subsoil of alluvial sand and clay, there being a large amount of turfy matter on the surface. Plots 1 and 5 are to the east, plot 1 at the north. Plots 6 and 7, commenced a year later, are to the west, plot 6 being next the south. All the plots have received the same amount of lime (CaO), except plot 5. The west ends (¼) of plots 1 to 5, and the east ends of plots 6 and 7, are fenced off for mowing.

LIME FOR PASTURE IN BACK BUTTS FIELD.

Plot.	Dressings applied April, 1907.	Average annual cost.	Weight of hay.		
			1916.	Average of ten years 1907–16.	Average annual increase over plot
		s. d.	cwt.	cwt.	cwt.
1	2 tons ground lime	5 7	33	28¾	**7¼**
2	3⅓ tons ground limestone... ...	6 10	32¾	26¾	**5¼**
3	2 tons ordinary lime	3 1	30¼	26	**4½**
4	No dressing	—	34½	21½	—
5	1 ton ground lime	2 9	27½	20	**−1½**
	Dressings applied March, 1908.			Average of nine years 1908–16.	
4	No dressing	—	34½	20¾	—
6	5 tons lime mud	3 1	29	22½	**1¾**
7	2 tons ordinary lime	3 6	23¼	23¼	**2½**

Basic slag (10 cwt. an acre, containing 200 lb. phos. acid) was applied on a strip (one-quarter of plots) at the east end of plots 1 to 5, in June, 1907; and, similarly, on the west end of plots 6 and 7, in March, 1908. All these areas received a similar dressing in November, 1911, 5 cwt. an acre in December, 1914, 5 cwt. an acre in December, 1917, and 5 cwt. an acre in December, 1920.

Superphosphate (7 cwt. an acre, containing 100 lb. phos. acid) was applied on strips (one-quarter of plots) inside the slag strips in March, 1909, in March, 1912, in December, 1914, in December, 1917, and in December, 1920. Superphosphate was inadvertently applied on the untreated and grazed portions of plots 6 and 7 in December, 1914.

Results.—Ground lime is more effective than ground limestone, and both have done rather better than ordinary lime. The half dressing of ground lime, although it has not increased the hay, has considerably improved the herbage. On the portions of the plots that are grazed, slag is evidently the most effective dressing, and shows nearly as good results without as with lime. On the other hand superphosphate gives a poor result when applied alone, but a good result when applied with lime. The lime dressings applied alone are making considerable improvement, especially in *fining* the pasture.

West Well Close.—See Guide, 1921.

Improved Pasture in disused clay pits and waste hollows.—Basic slag of high grade, 10 cwt. an acre, applied February, 1918, has developed clover and greatly improved the pasture in the Tilework field at Paradise, as well as on the banks of the Floodgate burn, extending from Paradise to below the Hanging Leaves fields. The banks of the burn, even under trees and near whin bushes, have responded well to the slag. The untreated strips on these banks show how poor the pasture was in its original condition. These are in marked contrast to the treated land. In parts where bracken was growing strongly the grazing stock are treading this well down in getting at the improved herbage developed by the clover. The quick action of slag here has been a special feature.

Eradication of Thistles.—The following plots are in duplicate on the east and west sides of the southern half of Long Riggs pasture field. The plots run north and south. There are three riggs in each plot. They were laid down in June, 1917, were treated in that year, again in 1918 and 1919 as follows:—

Plot 1.—(To west). Thistles untouched.
Thistles numerous and growing vigorously.

Plot 2.—Thistles cut by hoe when not more than 4 to 6 inches high, about middle of June, and again cut about three weeks later. (In 1917, cut on June 30th and July 20th, and about same dates in later years).

Thistles in 1918 reduced to one-third, and those remaining much less vigorous than on plot 1.

,, **3.**—As for plot 2, but thistles cut by mowing machine.

Thistles in 1918 reduced to one-fourth, and those remaining even less vigorous than on plot 2.

,, **4.**—As for plot 2, thistles cut by thistle cutting machine.

Thistles in 1918 reduced just over one-half, and those remaining were more vigorous than on plots 2 and 3.

,, **5.**—Thistles cut by hoe when not more than 4 inches high, first cutting ten days earlier than plot 2, and other two cuttings each at intervals of three weeks. (In 1917, June 22nd, July 13th, and August 4th, and about same dates in later years).

Thistles in 1918 reduced to one-fifth and those remaining were weaker than on any of the plots.

,, **6.**—Thistles cut by hoe once only, when stems well matured in middle of August.

Thistles in 1918 reduced to three-fifths only, and the plants remaining were still vigorous.

The thistles have not been cut since 1920. The results are now very definite. Three years' cuttings on plots 2, 3, 4 and 5 have eradicated the thistles. The trials showed definitely that two or three years' successive cuttings, especially as practised on plots 2, 3 and 5, effectively removed thistles from pasture. The result on plot 4 is not quite so definite, although good. The late cutting on plot 6 is not effective. It has been clearly shown that two years' proper cutting of thistles in a pasture field, or two years' mowing for hay, if mowing is done early and close to the bottom, will practically remove thistles.

MANURES FOR MEADOW HAY IN PALACE LEAS FIELD.

These results have been fully dealt with in Bulletin 8. A summary of them for the past twenty-four years is given in the table on page 19. It is important to note that in this table the average gain or loss is based simply on the weight of hay produced, this being all valued at 80/- a ton. Striking results are, that, even when the quality of the hay is not considered, sulphate of ammonia does not profitably increase the crop, either alone or in conjunction with other manures (compare plots 6 and 7, 8 and 10, and 12 and 13). Phosphates as basic slag give the most profitable returns of the artificial manures. In 1919 one-third of each of these plots was ploughed out, thus reducing their size from $\frac{1}{2}$ to $\frac{1}{3}$ acre in area.

Palace Leas Meadow Hay Results based on quantity of Hay.

RESULTS PER ACRE FOR 25 YEARS, 1897-1921. SOIL: STIFF BOULDER CLAY.

The plots are ⅓ acre in area. Dung is applied in the autumn, and artificials in the early winter, except nitrate of soda and sulphate of ammonia, which are applied in April.

Plot.	Manures per acre annually, unless otherwise stated. (Supers. were used in alternate years instead of slag from 1897 till 1906).	Average annual cost of manures.	25 years, 1897–1921.					Plot.
			Twenty-fifth crop (1921).	Average crop of twenty-five years.	Average increase over plot 6.	Value of increase over plot 6 at £4 a ton.	Average annual gain or loss (–)	
		S. D.	CWT.	CWT.	CWT.	S. D.	S. D.	
1	8 tons dung, 37½lb. sulph. am., 50lb. nitrate, 150lb. slag, 50lb. mur. potash...	84/9	36	**41¾**	22¾	91/-	**6/3**	1
2	8 tons dung	60/-	31½	**39¾**	20¾	83/-	**23/-**	2
3	8 tons dung (1897, etc.) alternated with artificials for plot 1 (1898, etc.)...	42/5	23¼	**34**	15	60/-	**17/7**	3
4	8 tons dung each alternate year (1897, etc.)	30/-	24¼	**31¾**	12¾	51/-	**21/-**	4
5	16 tons dung each 4th year (1897, etc.) with artificials for plot 1 in other years...	48/7	24½	**34**	15	60/-	**11/5**	5
6	Unmanured	......	14¾	**19**	......	......	......	6
7	150lb. sulph. am. (30lb. nitrogen)	21/4	19½	**23**	4	16/-	**-5/4**	7
8	300lb. slag (50lb. phos. ac.)	10/6	14	**25¼**	6¼	25/-	**14/6**	8
9	100lb. mur. potash (50lb. potash)	12/4	14½	**16**	- 3	- 12/-	**- 24/4**	9
10	150lb. sulph. am. and 300lb. slag	31/10	22	**29¾**	10¾	43/-	**11/2**	10
11	150lb. sulph. am. and 100lb. mur. potash	33/8	18¾	**21¼**	2¼	9/-	**- 24/8**	11
12	300lb. slag and 100lb. mur. potash	22/10	14¼	**25½**	6½	26/-	**3/2**	12
13	150lb. sulph. am., 300lb. slag, 100lb. mur. potash ...	44/2	23½	**30¾**	11¾	47/2	**3/-**	13
14	75lb. sulph. am., 100lb. nitrate of soda, 300lb. slag, 100lb. mur. potash	49/6	20½	**31**	12	48/-	**- 1/6**	14
15	As for plot 14, but in alternate years only (1897, etc.) ...	24/9	19	**23½**	4½	18/-	**- 6/9**	15
16	Half the dressing of plot 14 (same artificials as for plot 1)	24/9	15¼	**22¾**	3¾	15/-	**- 9/9**	16

Palace Leas Meadow Hay Results based on quality of Hay.

From the feeding results recorded in the Guide for 1921 it is possible to assume values for the hay from each plot on the Palace Leas Field with approximate accuracy. A standard value of 80/- a ton is assumed for the hay of the untreated plot as is shown in the following table:—

Plot.	Manures per acre annually, unless otherwise stated. (Supers. were used in alternate years instead of slag from 1897 till 1906.)	Average annual cost of manures.	Average crop of twenty-five years.	Value of hay per ton assumed from feeding results.	Average annual value of crop.	Increase in value over unmanured plot.	Average annual gain or loss (–).	Plot.
		S.D.	CWT.	S.D.	S.D.	S.D.	S.D.	
1	8 tons dung, 37½lb. sulph. am., 50 lb. nitrate, 150lb. slag, 50lb. mur. potash...	84/9	41¾	**73/4**	153/1	77/1	**– 7/8**	1
2	8 tons dung	60/–	39¾	**91/6**	181/10	105/10	**45/10**	2
3	8 tons dung (1897, etc.) alternated with artificials for plot 1 (1898, etc.)	42/5	34	**72/–**	122/4	46/4	**3/11**	3
4	8 tons dung each alternate year (1897, etc.)	30/–	31¾	**85/9**	136/2	60/2	**30/2**	4
5	16 tons dung each 4th year (1897, etc.) with artificials for plot 1 in other years	48/7	34	**72/–**	133/3	57/3	**8/8**	5
6	Unmanured	......	19	**80/–**	76/–	—	—	6
7	150lb. sulph. am. (30lb. nitrogen)	21/4	23	**72/–**	82/11	6/11	**– 14/5**	7
8	300lb. slag (50lb. phos. ac.)	10/6	25¼	**93/–**	117/6	41/6	**31/–**	8
9	100lb. mur. potash (50lb. potash)	12/4	16	**80/–**	64/–	– 12/–	**– 24/4**	9
10	150lb. sulph. am. and 300lb. slag	31/10	29¾	**84/–**	125/–	49/–	**17/2**	10
11	150lb. sulph. am. and 100lb. mur. potash	33/8	21¼	**72/–**	76/6	– –/6	**– 34/2**	11
12	300lb. slag and 100lb. mur. potash	22/10	25½	**101/9**	129/9	53/9	**30/11**	12
13	150lb. sulph. am., 300lb. slag, 100lb. mur. potash ...	44/2	30¾	**89/2**	137/2	61/2	**17/–**	13
14	75lb. sulph. am., 100lb. nitrate of soda, 300lb. slag, 100lb. mur. potash	49/6	31	**84/9**	131/5	55/5	**5/11**	14
15	As for plot 14, but in alternate years only (1897, etc.) ...	24/9	23½	**84/9**	99/7	23/7	**– 1/2**	15
16	Half the dressing of plot 14 (same artificials as for plot 1)	24/9	22¾	**84/9**	96/3	20/3	**– 4/6**	16

The feeding results indicate that dung and complete artificials, as well as nitrogenous manures, considerably reduce the quality of the hay; that dung alone rather improves the quality; and that phosphates greatly improve the quality, especially when a potash manure is added. Taking weight and quality of hay into account, the best results are given on plots 2 and 4 (dung alone), on plot 8 (slag alone), and on plot 12 slag and muriate of potash).

Use of slag and dung.—As slag and dung have been found a most effective dressing for meadow hay in Lower Brick Field two triangular quarter acre plots have been under experiment since 1907 in Palace Leas Field just below plot 20, the special object being to compare slag and dung with the various combinations of artificials and dung on plots 1-5.

Plot.	Treatment per acre.	Average annual cost of manures.	Yield of hay.		Average increase over untreated plot.
			1920.	Average of fourteen years.	
		s. d.	cwt.	cwt.	cwt.
21	8 tons dung and 5 cwt. slag (100lb. phos. ac.) annually	79/6	41½	**30⅓**	11
22	As for plot 21, but in alternate years (commencing 1907)	39/9	34¾	**25¾**	6¼
6	Untreated	—	21¼	**19½**	—

The good effects of slag and dung on hay and pasture are probably due to the following:—Dung is fairly rich in nitrogen and especially in potash, but is rather poor in phosphates. It also adds useful organic matter. Basic slag contains phosphates and lime, both apparently in sufficient quantity and in suitable condition for hay and pasture. The effect of the slag is to maintain and develop clovers, which are little helped by dung alone, and the quality of the hay is therefore improved. In Lower Brick Field, poor meadow hay was treated every third year for a considerable time with 5 cwt. high grade basic slag and 10 tons dung, both per acre. As a result of this a poor, thin, benty pasture was converted into a sweet and close sward of herbage with abundance of clover. This field gave early and nutritive herbage in spring till June 1st for ewes and lambs, and excellent quality of hay afterwards, the average crops for seven years being 29½ cwt. per acre.

Yellow Rattle Weed:—As this weed was very prevalent on some of the meadow hay plots in Palace Leas Field it was decided in 1916 to mow one-third to the west end of plots 1-16 early, before the seeds of this weed had become ripe. The early mowing was done in the third week of June.

When the plots were closely examined on May 5th, 1917, on the part mown early the previous year no yellow rattle was found, while on the remainder of the plots there was an abundance of young yellow rattle plants.

It was evident in 1917 that the crops of hay on the plots were considerably heavier after early mowing in 1916, probably to the extent of over 5 cwt. an acre. Early mowing was again practised in 1917 with the result that the yellow rattle plants have now disappeared from this field. The results of this trial are most important, as this troublesome weed does enormous harm in old land hay. It is thus shown that early mowing, before the seeds are formed, will get rid of this troublesome weed. Grazing meadow land for one or two years will give the same result. Dressings of salt were not effective in checking this weed. The early mowing of meadow hay in this field has also reduced many other weeds and given a large proportion of grass and clover herbage.

Lime Dressings on Palace Leas Meadow Hay Plots:—Four plots were laid down on March 18th, 1921, as cross dressings on the regular hay plots, each being about 18 feet wide, and running east to west. The dressings are as follows:—Plot 1 (to west) no lime; plot 2, 4 tons an acre of lime mud; plot 3, 2 tons an acre of ground lime; plot 4, 2 tons an acre of ground lime containing a high percentage of magnesia (34%).

Comparative Results with different Phosphatic Manures.

Slag of different qualities and bone meal in Long Riggs.

Plot.	Treatment per acre (February, 1908). Redressed December, 1910, December, 1913, December, 1916, and December, 1919.	Average annual cost of treatment.	Hay per acre.			Value of increase at 50/- a ton.	Avera annu gain loss (
			1921.	Average of fourteen years.	Average increase over plot 1.		
		s. d.	cwt.	cwt.	cwt.	s. d.	s. d.
1	(To the west.) No treatment	—	6	**7½**	—	—	—
2	10 cwt. high grade basic slag, 39·32% phosphates (200lb. phosphoric acid) ...	8/-	10	**22¼**	14¾	36/11	**28**
3	14 cwt. medium grade basic slag, 27·39% phosphates (200lb. phosphoric acid) ...	9/4	9	**21**	13½	33/9	**24**
4	19¾ cwt. low grade basic slag, 19·82% phosphates (200lb. phosphoric acid) ...	10/8	9¾	**19¼**	11¾	29/5	**18**
5	8¾ cwt. bone meal, 45·09% phosphates (200lb. phosphoric acid)	18/8	11	**20¼**	12¾	31/11	**13**

For notes on these results see Guide for 1921, and for other results with different phosphatic manures see Guide for 1917.

Specially prepared Basic Slags and Mineral Phosphates for Wild White Clover Ley and Pasture.—Plots, each ⅛th acre in area, were marked off in Long Riggs Field. They run east and west and plot 1 is to the south. Half of each plot is on poor and unimproved pasture, and the other half on similar land ploughed out and sown in July, 1917, without a corn crop, with a Cockle Park wild white clover seeds mixture. The soil is a poor and shallow clay on a subsoil of stiff boulder clay. The dressings were applied in October, 1917, repeated in October, 1920, and are as follows per acre. Each contained 200 lb. phosphoric acid. Attention should be given to the notes on the herbage of these plots and not to the weights of hay recorded.

	Phos. of Lime %	Citric Sol. %	Fineness. %	Weight of Hay per acre, 1921.	
				Old land. cwt.	New land. cwt.
Plot 1.—No manure	—	—	—	10½	10¾
„ **2.**—11·1 cwt. high grade basic slag	35·01	90·6	78·0	11½	11
„ **3.**—24·8 cwt. low grade basic slag	15·71	17·2	79·6	8¾	14
„ **4.**—17·8 cwt. fused basic slag and Tunisian phosphate in open hearth furnace	24·60	16·2	97·1	7	11½
„ **5.**— 4·1 cwt. Tunisian phosphate and 12·4 cwt. low grade basic slag	26·32	24·0	84·6	11	9½
„ **6.**— 8·3 cwt. Tunisian phosphate	47·52	37·9	94·6	13¼	14¾
„ **7.**—No manure	—	—	—	11	10¼

These tests compare :—(*a*) High grade basic slag of high citric solubility and low grade basic slag of low citric solubility (plots 2 and 3) ; (*b*) The effect of grading up low grade basic slag by adding Tunisian phosphate to this in an open hearth furnace (plots 3, 4, 5 and 6).

The herbage of these plots was carefully examined in May, 1921. The two untreated plots (1 and 7) had very poor herbage and stunted clover plants. Plots 2 and 6 had distinctly the best herbage with much clover, and plot 6 was even better than plot 2. Plots 3, 4 and 5 showed great improvement over the untreated plots, but for some reason (probably accidental) the herbage on these plots is not as much improved as that on plots 2 and 6. The dressings for plots 3, 4 and 5 got rather lumpy when stored, and it is probable that the lumps were not broken to their original fineness.

Manures applied on Pasture Land (per acre).

Most of the pasture land not under experiment received a first dressing of 10 cwt. an acre of high grade basic slag, and 5 cwt. an acre every third year thereafter. A record of these fields is given in the Guide for 1921. Their treatment with basic slag is being continued on the same plan.

Paradise Fields.—South West Field, Tilework Field, and the south bank of the Floodgate Burn between North and Middle Fields received 10 cwt. basic slag in Feb., 1918, and 5 cwt. in Feb., 1921. Strips, 3 riggs wide, near the east and west sides in Tilework Field, and on the bank have been left untreated. South East Field got the same dressing in Feb., 1919, a portion in the middle being left untreated. Near the N.E. corner of this field 4 tons lime mud were applied on 1 acre; beginning 4 riggs north of the part not treated with slag.

Back House Field, S.E.—The area formerly known as the Small Farms and the land to the south was laid away with rye in 1920, except small plots which were laid away in 1918 and 1919. This is mown annually for hay and is manured as follows (per acre): 10 cwt. basic slag for 1920 and every third year thereafter; 8 tons dung every third year, one-third, middle, 1922; one-third to south, 1923; and remaining third, 1924, and so on. This area has a poor and thin sandy soil and is lying direct on Millstone Grit sandstone.

Land ploughed out from old turf.—See Guide, 1921.

Palace Leas Field (ploughed out portion):—About 8 acres on the east of Palace Leas Field, mostly a sandy loam, was ploughed out in November, 1919, for oats in 1920. Great Mogul oats, 4½ bus. an acre, were sown on April 29th, on a good seed bed prepared mainly by the disc drill and the scrubber. As one-third of each of the old land hay plots was ploughed out this provided an excellent demonstration of the results of ploughing out unmanured land, and that treated for many years with various manurial dressings.

This was sown as a second corn crop in 1921 with Great Mogul oats on March 22nd, at the rate of 4½ bushels an acre. Owing to a bad attack by wireworm it was re-sown with Sandy oats at the rate of 4½ bushels an acre, after giving the land a thorough disc harrowing.

Sulphate of ammonia at the rate of 1 cwt. an acre was applied on that part which was previously the meadow hay plots; a strip was left untreated, and to east of this muriate of ammonia was applied at the rate of 100 lb. an acre.

This season to the north beans and oats are sown (see page 38), south of which are potatoes (see page 50).

Trials of Magnesian and other Limes:—The following cross-dressings per acre of lime were applied in Palace Leas Field on strips each two-thirds of an acre in area, the untreated portion being next to the present hay plots.

Plot 1 (to west).—Untreated.	
Plot 2	4 tons lime mud.
Plot 3	2 tons ground lime (free from magnesia).
Plot 4	2 tons ground lime (34% magnesia).

The dressings were applied on the plough furrows in February, 1921, before disc harrowing and cultivating for the oat crop.

Back House Field Rotation Experiments.

This set of experiments has been in progress since 1897, and the season of 1916 completed the results for 20 years. As the rotation of crops is a four-course one, five rotations have now been completed. The full results of the first and second four-course rotations were published in Bulletin No. 3, issued in 1905, of the third rotation (1905-1908), in the Guide for 1909, of the fourth rotation (1909-1912), in the Guide for 1913, and of the fifth rotation (1913-16), in the Guide for 1917. The soil is a light sandy loam, particulars of which and of the plots are given in the Guide for 1921.

RESULTS OF SIXTH ROTATION, 1917-20.

The plots were continued as for 1913-16, except that 100 lb. sulphate of ammonia were applied for oats and 50 lb. for barley, both per acre, instead of nitrate of soda. The sulphate of ammonia was harrowed in with the seed. Four tons an acre of lime mud were again applied to all the plots before ploughing the hay stubble in October, 1919. The table on page 28 gives the manuring and results for the four years.

The main results are:—

(1) Comparing plots 2 and 3, the application of dung for swedes and artificials for hay is again more satisfactory than artificials for swedes and dung for hay.

(2) It is striking how the oats on plots 5 and 6 suffered where half the roots were eaten off with sheep, when the results are compared with that of plot 4. Even on plot 7, which had extra artificials for the hay and cake fed to the sheep as on plot 6, the oat crop was little better than on plot 4. There was a heavy fall of snow when the roots were eaten off. It is probable that the young seeds, especially clover, were checked on plots 5 and 6 by the heavy crops of barley, with the result that much less nitrogen was collected in the clover root of the hay crop. If so, this will explain the comparatively small crops of oats on plots 6 and 7 and even on plot 5.

(3) On plot 8, with artificials for both swedes and hay, the hay crop was slightly better, but the oat crop not as good as with artificials for roots only on plot 4. The sulphate of ammonia probably somewhat checked the clover plants on plot 8.

(4) With artificials alone all the crops have suffered severely where a potash manure was withheld on plot 10, as compared with plot 8, which had a complete artificial manure. For this light soil a potash manure is essential when artificials only are used. Where, however, dung and artificials were applied on plots 3 and 18 the omission of a potash manure on the latter plot has not decreased but actually increased the crops. This result cannot be explained.

(5) Comparing plots 8 and 11 (artificials alone) and plots 3 and 17 (dung and artificials), sulphate of ammonia for the cereal crops has not increased. but diminished these crops. This confirms the now regular practice at Cockle Park of not applying nitrogenous manures to cereal crops, but rather to apply phosphatic manures to the hay crops so as to develop clovers and get from them the requisite nitrogen for the cereal crops. On the other hand, plots 12 and 13 show that dressings of sulphate of ammonia for the cereal crops have greatly improved these crops when heavy dressings of artificials were used.

(6) The heavy dressings of artificials on plot 12 have not given nearly as good results as the moderate dressing on plot 4. This shows how heavy dressings of certain artificial manures may do considerable harm.

(7) On plot 14 superphosphate was used for swedes, instead of the mixture of basic slag and superphosphate on plot 11. On plot 21, 3 cwt. superphosphate was used for swedes, in addition to the normal phosphatic dressing for plot 3. It was expected that the swede crops would be materially increased by these dressings, and this has not taken place on plot 14. The barley and oat crops have been increased materially by these dressings of superphosphate.

(8) Generally, dung has given better results, with or without artificials, than artificials alone on this light soil. It will be noted that basic slag on plot 19 and Belgian Rock Phosphate on plot 22, have not materially increased the hay crops. The probable explanation is that the rainfall of April, May and June in 1919 was exceptionally small, that being the year in which hay was grown on these plots.

Unfortunately, the hay growing seasons of 1911, 1915 and 1919 were all exceptionally low in rainfall, as will be seen from the following figures:—

	1911. Inches.	1915. Inches.	1919. Inches.	Average for 21 years. 1898–1918. Inches.
April	1·61	1·42	1·28	1·85
May	0·82	1·75	0·65	2·59
June	5·29	0·53	0·49	2·21

NOTE.—In 1911, April and May were exceptionally dry months, and the June rainfall was at the end of the month, there being over three inches of rain on midsummer day.

These were the years in which hay was grown on these plots in the last three rotations. The Cockle Park hay crop averages were exceptionally light in these years, no doubt because of the low rainfall. Probably because of this the results on these rotation plots were not nearly as good as on the other arable land at Cockle Park. A dry hay growing season inevitably means a poor development of clovers, and consequently a much reduced collection of nitrogen in the soil.

BACK HOUSE FIELD ROTATION EXPERIMENT, COCKLE PARK.

Results per acre of the first three crops of a sixth rotation, 1917–1920.
The standard dressing of artificials consists of (per acre) :—For swedes, 125 lb. sulphate of ammonia, 160 lb. superphosphate, 3 cwt. basic slag, and 100 lb. muriate of potash. This contains 25lb. nitrogen, 75 lb. phosphoric acid (¼ in superphosphate, ¾ in slag), and 50 lb. potash.
The standard dressing for hay consists of 100 lb. sulphate of ammonia (17.5 lb. nitrogen), 5 cwt. basic slag (100 lb. phosphoric acid), and 100 lb. muriate of potash (50 lb. potash).

Plot.	Manuring. D. = 10 tons of dung. A. = 7 cwt. artificials (complete). N. = 100 lb. sulphate of ammonia.	Cost of Manures for rotation.		Yield of produce during sixth rotation (1917–1920).							Plot.
				Swedes, 1917.		Barley, 1918.		Hay, 1919.	Oats, 1920.		
						Grain.	Straw.		Grain.	Straw.	
		s.	d.	tons.	cwt.	bushels of 56 lb.	cwt.	cwt.	bushels of 42 lb.	cwt.	
1	No manure (one-eighth acre)	—		6	0	18	18	18½	7½	14	1
2	A for swedes, ½ N for barley, D for hay, N for oats ...	147	3	26	3	25	20½	34½	40	22¾	2
3	D for swedes, ½ N for barley, A for hay, N for oats ...	142	2	25	11	39	28	32¾	41	24½	3
4	A for swedes	51	0	20	9	34½	19½	18¼	39	24½	4
5	A for swedes, half swedes fed off by sheep with 14 cwt. hay	72	8	21	3	38	30¾	21¼	33½	18¾	5
6	As for plot 5, with 10 cwt. soya cake fed	108	4	21	17	50½	28	20¾	30¼	16½	6
7	As for plot 6, with A for hay	154	3	18	3	63½	30¾	32	41½	22	7
8	A for swedes, A for hay	96	11	21	9	35½	19¼	27	35¾	18½	8
9	No manure (one-eighth acre)	—		4	0	24	15¾	18	12¼	22½	9
10	As for plot 8, less muriate of potash	72	5	8	9	12½	10½	22½	19½	10¾	10
11	As for plot 8, ½ N for barley, N for oats	118	2	19	3	29½	16½	28¼	32½	16¾	11
12	2 A for swedes, A for hay	147	11	13	11	29½	15½	27¼	37½	18	12
13	As for plot 12, ½ N for barley, N for oats	169	2	25	9	44½	20¼	27½	46½	26	13
14	As for plot 11, but all root phosphates as superphosphate	151	8	20	0	32	25½	25	50¼	21	14
15	D for swedes	75	0	21	11	44	25¼	26½	46¾	23¾	15
16	D plus 5 cwt. slag for swedes and 5 cwt. slag for hay	189	0	22	3	42	21½	24½	46½	22	16
17	As for plot 3, but no N for cereals	120	11	25	3	50½	26	36¼	54½	22	17
18	As for plot 3, but no potash for hay	129	11	23	8	53½	24	33½	52	24½	18
19	D plus 5 cwt. slag for swedes, D plus 5 cwt. slag for hay	189	0	24	11	55	25¾	39	53½	25¾	19
20	D for swedes, D for hay	150	0	22	11	46	26½	39	50	25½	20
21	As for plot 3, with 3 cwt. supers for swedes	151	5	26	3	56	27½	23½	54¾	28½	21
22	As for plot 19, but 4⅓ cwt. Belgian rock phosphate replace slag	184	0	23	3	55	29	35½	44¾	22¼	22

SCHEME OF MANURING FOR THE SEVENTH ROTATION, 1921-24.

The following gives the plan for the manuring of the plots. The crop was swedes in 1921, and is barley for 1922. The manuring has been modified after consideration of the results of previous rotations, but as far as possible the continuity of the kind of manuring has not been altered.

Plot.	Manuring per acre. N. = 100. lb. sulphate of ammonia. S. = 5 cwt. basic slag. P. = 357 lb. kainit (50 lb. potash). D. = 15 tons dung.	Weight of swedes an acre, 1921.	
		tons.	cwt.
1	No manure (one-eighth acre).	6	3
2	2 N + S for swedes, D for hay.	15	11
3	D for swedes, S + P for hay.	19	13
4	2 N + S + P for swedes.	11	3
5	As for Plot 18, $\frac{1}{2}$ swedes fed off with 14 cwt. hay.	20	14
6	As for plot 5, with 10 cwt. high grade cake fed.	19	16
7	As for plot 6, in addition N for hay and for oats.	20	0
8	2 N + S + P for swedes, S + P for hay.	14	1
9	No manure (one-eighth acre).	6	17
10	2 N + S for swedes, S for hay.	11	11
11	2 N + S + P for swedes, N for barley, N + S + P for hay, N for oats.	14	0
12	D for swedes.	16	9
13	D for swedes, N for barley, N for hay, N for oats.	17	9
14	2 N + P + 6 cwt. supers for swedes, S + P for hay.	13	8
15	D for swedes.	17	9
16	D + S for swedes, S for hay.	17	11
17	D for swedes, N for barley, S for hay, N for oats.	19	1
18	D for swedes, S for hay.	16	14
19	$\frac{2}{3}$ D + S for swedes, $\frac{2}{3}$ D + S for hay.	16	9
20	$\frac{2}{3}$ D for swedes, $\frac{2}{3}$ D for hay.	19	0
21	D + 3 cwt. supers for swedes, S for hay.	21	9
22	$\frac{2}{3}$ D + $4\frac{1}{2}$ cwt. rock phosphate for swedes, $\frac{2}{3}$ D + $4\frac{1}{2}$ cwt. rock phosphate for hay.	19	9

VARIETIES OF OATS.

Trials of varieties of oats have been conducted at Cockle Park since 1902. The general results have been as follows:—

1. Oats from Canada have given remarkably good results Among these Banner, Sensation, and Thousand Dollar oats have all done well. It has also been found that oats from Canada are likely to do much better in the first year of their introduction than afterwards.

2. Strong strawed oats like Storm King have not given good results at Cockle Park, and are therefore not now included in the trials.

3. Fine strawed oats like Blainslie and Tam Finlay have given the finest straw for fodder, and grow on a cold clay soil in a bad season better than the other varieties. They are, however, considerably behind the others as grain producing oats.

For good quality grain, Victory, Banner, Mammoth White Cluster, Original Crown, Yielder and Sensation oats have given excellent results. Blainslie oats give comparatively light grain per bushel. The straw of this variety is the finest for fodder. Great Mogul and Black Bell II. are black oats with spreading ears. These, with Blainslie, withstood well the daddy longleg grub attack in 1913, and are well worth attention where attack from this grub is feared after breaking up old and matty turf. Sensation and Yielder are excellent white oats with rather large grain, and are the earliest ripening oats.

Oats after a wild white clover ley, especially if this has received basic slag, should not be treated with nitrogenous manures such as nitrate of soda or sulphate of ammonia. If the ley has not received basic slag, a few cwt. an acre of high grade basic slag will probably improve the quality and to some extent increase the yield of the grain. Where a small or moderate crop of oats is anticipated it is suggested that from 3 to 4 cwt. of high grade basic slag (37 per cent. phosphates) and from $\frac{3}{4}$ to 1 cwt. of sulphate of ammonia, both per acre, be harrowed in with the seed.

Varieties of Oats in West Tower Hill Field, after old turf, 1918.

REPORT MADE ON SEPTEMBER 3RD, 1918.

Plot.	Variety and seed rate per acre in bus.	When ready to cut.	Estimated crop* per acre. Bus. of 42 lb.	Remarks.
1	Great Mogul 4½ ...	4 days	54	Strong straw and big ears, thin in places.
2	Black Bell II. 4 ...	2 days	51	Like last, but rather thinner.
3	Black Tartarian, 4⅓ ...	4 days	48	Rather thin, but even crop.
4	Sandy 3¾	9 days	58	Very even, almost full crop, fairly thick on ground.
5	Blainslie 3½	10 days	58	Like last.
6	Tam Finlay 3¾ ...	13 days	53	Like last, rather more straw. Straw perhaps a little stronger.

* It was impossible to weigh the crops. A plot of Sandy oats was cut and when threshed, yielded 57 bus. an acre.

Varieties of Oats in West Tower Hill Field, after old turf, 1918—*Continued.*

REPORT MADE ON SEPTEMBER 3RD, 1918.

Plot.	Variety and seed rate per acre in bus.	When ready to cut.	Estimated crop* per acre. Bus. of 42 lb.	Remarks.
7	Hamilton 4	5 days	57	Very even, but rather thinner than last. Heavier corn.
8	Payrent 3¾	3 days	59	Straw a very little finer than last, but very like it.
9	Victory 5	6 days	50	Very thin in places, but in parts a fair crop.
10	Banner 5	3 days	54	Thicker and more even than last.
11	Birlie 3¾	Now	56	Very thick and even on ground. Shorter and finer quality straw.
12	Potato 4	Now	57	Similar to last, but rather taller straw. Very even on ground.
13	Canadian Western	2 days	49	Thinner on ground. Stronger straw, like Banner.
14	Sandy, 50% more seed	8 days	60	Thicker on ground than plot 4, but heads not so strong. Not paid for extra seed.

*It was impossible to weigh the crops. A plot of Sandy oats was cut and when threshed, yielded 57 bus. an acre.

The Sandy oats came from Banffshire; they have smaller grain, with a reddish tinge and finer straw; they are probably the least liable to have shed grain in harvesting; they have long been favourite oats in the exposed districts of Scotland. Tam Finlay oats came from Ayrshire; they have long and thin grain, and the straw is even finer than that of Sandy oats. Hamilton oats came from Aberdeenshire; they are a variety of Potato oats, and among the old-fashioned kinds are a good cropper. The Birlie oats came from Kincardineshire; they have smaller grain, rather finer straw, and ripen a little earlier than Potato oats, which they resemble.

Birlie oats were most mature on this date, and were the best standing crop. Potato oats were very like Birlie, but of rather heavier grain and stronger straw. Hamilton oats were standing fairly well, and a nice crop. Sandy oats were probably the best crop, but the straw was lodged rather badly. Victory, Banner and Canadian Western oats suffered most from the attacks of wireworm and daddy longleg grub, and showed little power to recover from the damage caused by these pests. Sandy, Hamilton, Payrent, Birlie and Tam Finlay oats withstood the attacks of these pests remarkably well, and all these made remarkable recoveries from the damage caused by them. Birlie and Potato oats also did well in this respect, as well as Great Mogul and Black Bell II. oats. Black Tartarian oats suffered somewhat, but not severely from these pests.

Sandy oats, sown at the rate of 3¾ bushels an acre, gave a considerably thicker crop than Victory or Banner oats, sown at the rate of 5 bushels an acre. Where Sandy oats were sown at the rate of 5⅝ bushels an acre (50% more seed) little advantage was secured, as the crop was thick enough with the normal seeding. In the Lower Brick Field, Yielder oats, sown at the rate of 5½ bushels an acre on ploughed out old turf, gave much too thin a crop because of wireworm and leather-jacket attack. Two widths of the drill of these oats, sown at the rate of 8¼ bushels an acre (50% more seed), gave none too thick a crop. This comparison shows that for sowing after old turf infested with the foregoing pests, a good tillering oat like Sandy is far better suited than a bad tillering oat like Yielder.

Trials of Oats, 1921.—These were made in Backhouse Field (S.W.) on a sandy loam soil after a one year's ley. The plots are each ¼ acre in area. They were sown on March 14th.

Plot.	Variety.	Source.	Seed rate per acre, bushels.	Yield, 1921. Grain, (bus. of 42 lbs.)	Straw, cwt.
1	Great Mogul	Svalöf, Sweden, 1912	4½	57	24½
2	Black Bell II.	Svalöf, Sweden, 1912	4	57	21¼
3	Original Crown	Svalöf, Sweden, 1920	5	70	24
4	Victory	Svalöf, Sweden, 1920	5	80	29
5	Yielder	Gartons, 1920	6	59	25½
6	Sandy	Scotland, 1918	3¾	72	28

On the land to the south of the varieties Sandy oats were sown and to the west Victory. The eastern halves of the Victory and Sandy portions were dressed with sulphate of ammonia at the rate of ¾ cwt. an acre.

Frit-Fly on Oats.– This fly has given much trouble on oats in recent years. In 1921 in Backhouse Field (S.W.) Great Mogul oats were sown on two plots, each half an acre in area. The plot sown on November 9th, 1920, yielded 74 bushels an acre; while that sown on April 14th, 1921, gave only 33 bushels an acre. On the variety trials the same oats, sown on March 14th, yielded 57 bushels an acre. This season in East Tower Hill Field (N.) two 1 acre plots were sown on October 15th. Plot A (to south) was sown with Grey Winter Dun oats, and plot B (next to spring sown variety plots) with Great Mogul oats from last season's November sown crop. In both cases the seed rate was 6 bushels an acre.

Trials of Oats, 1922.—These are being made in East Tower Hill Field (N.) on a sandy loam soil after one year's ley. The plots are each $\frac{1}{3}$ acre in area excepting plots 7 and 8 which are $\frac{1}{6}$ acre. They were sown on April 7th, except plot 1 which was sown later on April 18th. Plot 1 is next to the winter sown oats.

Plot.	Variety.	Source.	Germination %	Weight of 500 grains grams.	Seed rate per acre. bus.
1	Great Mogul (late sown)	Svalöf, Sweden, 1912	92	14·66	4
2	Great Mogul	Svalöf, Sweden, 1912	92	14·66	4
3	Black Bell II.	Svalöf, Sweden, 1912	93	14·12	4
4	Original Crown	Svalöf, Sweden, 1920	94	17·52	5
5	Victory	Svalöf, Sweden, 1920	94	17·96	5
6	Yielder	Gartons', 1920	89	20·27	6
7	Webb's Challenge	Cumberland, 1922	95	18·17	5½
8	Black Orion	Ministry of Agric., 1922	91	17·50	5
9	Black Bear	Ministry of Agric., 1922	99	13·47	4

The remainder of the land is sown with Victory oats. In Upper Brick Field on a clay soil after three years' ley the following varieties of oats were sown on April 12th. The plots are $\frac{1}{4}$ acre in area.

Plot.	Variety.	Source.	Germination %	Weight of 500 grains grams.	Seed rate per acre. bus.
1 (to north)	Canadian Western	Canada, 1922	95	19·44	5½
2	Banner	Canada, 1922	96	16·12	5
3	Banner	Northumberland, 1922	94	14·39	4½
4	Webb's Challenge	Cumberland, 1922	95	18·17	5½
5	Regenerated Victory	Garton's, 1922	97	19·01	5½
6	Victory	Svalöf, Sweden, 1922	94	17·96	5½

The remainder of the land is sown with Canadian Western and Victory oats, the former to the north and the latter to the south of the plots.

On 4½ acres of land in Castle Steads Field, as a second crop after ploughing out, Great Mogul oats were sown. The land received a dressing of 5 cwt. high grade basis slag and $\frac{3}{4}$ cwt. sulphate of ammonia at the time of sowing. These oats were sown on April 17th, but were very badly attacked by wireworm. It was decided to sow with rape and this was done on May 31st, at the rate of 8 lb. per acre. The land was disc harrowed twice and harrowed once before sowing the rape, and afterwards rolled with the Cambridge roller to consolidate the land as much as possible. A ¼ acre plot received 4 cwt. per acre of common salt harrowed in before sowing the rape.

Trefoil.—4 lb. an acre has been sown with the oats in East Tower Hill Field (N.). Italian ryegrass 3 lb. an acre was sown in addition on 4 acres.

TRIALS OF VARIETIES OF BARLEY.

Trials of varieties of barleys have been conducted since 1903. The following table gives the results for 1918, as well as the average results for the past ten years or under. They were grown in 1918, in Upper Brick Field (W.), on a poor clay loam soil, after swedes, on plots ¼ acre in area. They were all sown on March 26th.

Variety.	Source.	Yield.				Seed rate per acre.	Natural weight per bushel.	Weight of 500 grains.	Number of years grown at Cockle Park.
		Grain. (bus. of 56lb.)		Straw. cwt.					
		1918.	Av. of 10 yrs, 1909-18	1918.	Av. of 10 yrs, 1909-18				
						bus.	lb.	grams.	
*Archer ...	(Danish) East Lothian, 1909	—	**46**§	—	33§	4	—	—	10
*Chevalier	Cockle Park since 1903	**54½**	**44**	29	31½	4	54	23·3	16
*Hannchen	Svalöf, Sweden, 1911	**47**	**41**‡	34¾	30¼‡	4	53	23·5	8
†Primus ...	Svalöf, Sweden, 1911	**46½**	**36¼**‡	23¾	27‡	4	53	25·3	8
†Goldthorpe	Cockle Park since 1903	**59¼**	**42**	22¼	29¼	4	54	24·8	16
†Maltster ...	Garton's, 1910 ...	**61½**	**42¼**§	26½	30§	4	52	24·5	9
†Archplume	Cambridge, 1916	**54**	—	29½	—	4	54	23·6	3
Common...	Scotland, 1918 ...	**45**	—	27¼	—	—	52	—	1

* Nutans or Chevalier type.
† Erectus or Goldthorpe type.
‡ Average of eight years.
§ Average of nine years.

The last four barleys in the table are of the Goldthorpe type, and have short, broad ears, while the remainder are of the Chevalier type, and have long narrow ears. The former usually ripen a week or ten days earlier. Goldthorpe barley has always been valued higher for malting purposes (over 3/- a quarter) than Chevalier. The better ripened and more floury grain of Goldthorpe is probably due to its early maturity and to its less liability to become lodged or laid. In seasons when straw is deficient Chevalier produces most grain, but in good barley years Goldthorpe is the largest grain producer. Varieties of barley grown at Cockle Park for some years are usually better crop producers than those recently introduced, as is fully shown from the results of past years. The Swedish barleys, Hannchen and Primus, grown at Cockle Park since 1911, gave poor crops in the first years, but are well up to the average in later years.

The common barley was obtained from the Lauderdale district. It is especially suitable for growing on light soils, and possesses the further advantage that it ripens fully a fortnight earlier than any other barley. Hence it does well in late districts.

Barley for malting should be well ripened before cutting, and the crop should not be carried till the ears have been well hardened by exposure to sun and air. Good malting barley grain has a white, floury appearance when cut through the middle, and weighs rather less per bushel owing to its being fully matured. Damaged grain is disliked for malting, as such grain becomes mouldy in the malting process and the value of the malt is reduced. Close thrashing should therefore be avoided.

For feeding purposes, however, barley is best cut before it is dead ripe, thus getting the heaviest weight per bushel and the heaviest crop of grain. The grain is more " flinty " when cut and not so " floury " as in malting grain.

Trials of Barley, 1922.—These are being made on a clay loam soil in Backhouse Field (N.W.). The plots are each $\frac{1}{3}$ acre in area. They were sown on April 10th.

Plot.	Variety.	Source.	Germination %	Weight of 500 grains grams.	Seed rate per acre. bus.
1	Regenerated Archer*	Gartons, 1922	98	21·29	4
2	Admiral Beatty*	Gartons, 1922	99	19·84	4
3	Regenerated Standwell†	Gartons, 1922	100	24·57	4
4	Regenerated Maltster†	Gartons, 1922	100	24·94	4

* Nutans or Chevalier type. † Erectus or Goldthorpe type.

The remainder of the land was sown with Maltster (home seed) at the rate of 4 bushels an acre, on April 10th. On the rotation plots, Backhouse Field (S.E.), Goldthorpe barley (home seed) was sown at the rate of 4 bushels an acre on April 11th. On the land below the plots Gold (Svalöf) barley was sown.

TRIALS OF VARIETIES OF WHEAT.

Four varieties of wheat were grown in the two years 1905 and 1906, with the following average results in grain an acre:—(1) Squarehead Master, 50 bushels; (2) Carter's Royal Prize, $35\frac{1}{3}$

bushels; (3) Scholey's Squarehead, 42½ bushels, and (4) Hunter's White, 36¼ bushels.

Variety.	Source.	Yield of grain.				
		1910 (bus. of 63 lb).	1911 (bus. of 63 lb).	1913 (bus. of 63 lb).	1914 (bus. of 63 lb).	1915 (bus. of 63 lb).
Squarehead Master	Drem, 1913* ...	**43¾**	**37½**	**44**	**55**	**45½**
Squarehead	Drem, 1912* ...	...	...	**46**	**54½**	**50½**
Browick Grey Chaff	Drem, 1913 ...	**42**	**39½**	**41½**	**56½**	**57½**
Extra Squarehead II.	Svalöf, 1913 ...	...	...	**45½**	**52⅔**	**51½**
New Victor	Gartons', 1913...	...	...	**51**	**54¼**	**48½**
Eclipse	Hepscott, 1914...	...	...	...	**56**	**41**
Iron	Svalöf, 1914 ...	...	...	...	**57½**	**69½**
Little Joss	Cambridge, 1915	...	...	...	...	**36**
Regenerated Browick	Gartons', 1913...	...	...	**46½**	**56¾**	**52**
Regenerated Squarehead Master	Gartons', 1913...	...	...	**38**	**54¾**	**50**
Bon Fermier	Drem, 1913 ...	...	...	**37½**	...	...
Grenadier	Svalöf, 1915 ..	...	**35½**	...	...	...
Scholey's Squarehead	....	**46¼**	**44**	...	...	...
French Marvel	Lincolnshire, 1910	**30½**	...	...	...	...

* These were from another source for 1910 and 1911.

In 1918 Iron (Svalöf) wheat gave 65 bushels an acre in Lower Brick Field as a second corn crop after ploughing out old ley. In 1919 on a poor clay soil in Mid-Tower Hill Field after summer fallow the following results an acre were obtained; Iron, 59 bushels; Yeoman, 67½ bushels; Benefactor, 66½ bushels.

Prevention of Bunt and Smut on Wheat, Barley and Oats.—At Cockle Park when oats, barley or wheat have suffered from smut the dressing of the seed grain with one tablespoonful (½ oz.) of commercial formalin in one gallon of water for four bushels of seed grain has got rid of the trouble. The grain should be spread on a watertight floor, and carefully turned several times after watering with the formalin solution. It is an advantage to let the seed dry as well as possible before bagging. It should be sown not later than 24 hours after treatment. Care should be taken that the formalin is of standard quality, and that it contains 40 per cent. formaldehyde.

The above treatment, however, as well as the ordinary method of pickling with copper sulphate (from ½ to 1 lb. in one gallon water for four bushels seed) has failed to check the occurrence of bunt (stinking smut) of wheat. As this is so, the following method of treating the seed wheat for 1920 was adopted. Every four bushels of wheat seed was treated with ½lb. copper sulphate, dissolved in 2 gallons water.

Special care was taken thoroughly to wet each grain by turning repeatedly with a shovel. This is necessary to get rid of the small air bubbles which adhere to the grain and protect the spores of the disease. In the past a stronger solution of copper sulphate has been used, but the quantity of water has probably not been sufficient thoroughly to wet the grain and get rid of the spores. The mixing with the shovel must be thoroughly done. It is hoped that farmers who have bunt in their wheat seed will try this method and report on the results. Care should be taken that the copper sulphate used is of standard quality.

VARIETIES AND MANURING OF BEANS.

Trials made in 1906, 1907 and 1910, showed:—(1) That the Scotch Horse bean gave considerably heavier crops than the Norfolk Tick bean; (2) that basic slag gave better results than superphosphate; (3) that muriate of potash when added to slag, on the average increased the grain by 7 bushels, and when dung was also applied by over 6 bushels; (4) that lime mud added to superphosphate considerably increased the crop.

The following manures an acre gave good results with beans:—

(1) 10 tons dung, 6 cwt. basic slag, and 1 cwt. muriate of potash.
(2) 6 cwt. basic slag and 1 cwt. muriate of potash.

The trials showed that beans should be harvested when they are still green, and when the beans in the pod become black at the hilum.

Beans and Oats, 1920.—In Back House Field, N.W., on a strong clay loam, Scotch Horse beans were sown (2½ bushels an acre) on February 3rd. Sandy oats were sown a month later, one half of the area at the rate of 2 bushels, and the other at the rate of 1½ bushels an acre. Five cwt. of high grade basic slag and ¾ cwt. sulphate of ammonia, both per acre, were harrowed in when the beans were sown. The crop was oats in 1919, which had succeeded an excellent three years' ley of wild white clover. A crop of about 64 bushels an acre of grain was obtained, of which about three-fourths were oats and one-fourth beans. The straw was of great value for fodder. The crop was harvested when the beans were still green and when the beans in the pod had become black at the hilum. Very little grain was lost from the Sandy oats during the lengthened time the crop was in stook.

Spraying Charlock.—At the end of May the 1921 crop of beans and oats in Upper Brick Field was badly infested with charlock. It was decided to spray the worst infested part with a 4 per cent. solution of copper suphate (16 pounds copper sulphate dissolved in 40 gallons of water per acre). The remainder was sprayed with a 2 per cent. solution (8 pounds copper sulphate dissolved in 40 gallons of water per acre). A narrow strip was left untreated. The first spraying was done on May 26th. Unfortunately, rain fell soon afterwards, and rendered this spraying ineffective. Next morning was fine and spraying was again carried out as before. The day continued sunny until 5 p.m. when there was some rain, and more on the following day. Good results were noted a few days afterwards, but a third spraying was made on May 31st, this being the first ensuing fine day. No damage was done to the beans. The oats were rather yellowed at the top, but not really damaged. The charlock which was in the broad leaf and in bud was killed, but where it was in flower it was not checked so effectively. Spraying a fortnight earlier would have been advisable, but the results are promising. It is important to note that the beans were not damaged by the spraying.

Beans and Oats, 1922.—These are sown in Palace Leas Field, on the northern portion of the land ploughed out in 1919. Tick beans were sown broadcast by hand at the rate of 1½ bushels an acre on March 24th, on drills about 25 inches wide raised from the stubble. These were afterwards "scrubbed" down and cross harrowed, and 2 bushels an acre of Sandy oats were sown across with a disc drill on April 18th. The land received 5 cwt. an acre of high grade basic slag before sowing the beans, and later ¾ cwt. sulphate of ammonia was harrowed in.

GRASS AND CLOVER SEEDS AND SEEDS MIXTURES.

Trials of Important Grasses and Clovers.—Plots of these have been sown in the Lower Nursery every year since 1904. The results on these and on the rotation hay indicate that, under Cockle Park conditions:—

(1) Italian ryegrass does not stand well. The plants grown from home seed stand better than those from French seed.

(2) Tall oat grass is productive, and gives a quick return on a sandy loam soil, but is not so suitable for a clay soil.

(3) Meadow fescue, a valuable grass under certain conditions, fails to produce lasting plants.

(4) After perennial ryegrass, cocksfoot is undoubtedly the most valuable grass at Cockle Park. It does not produce a large bulk of herbage in first year's hay, but in later years it produces heavy crops *and nutritive herbage, if cut early.* When the seed of cocksfoot is obtained from New Zealand it produces plants with much more leaf foliage and it is later in flowering than when the seed is obtained from other countries.

(5) Timothy grass does not give as good results as in the west, where the climate is moister and the winters are milder.

(6) Red clover, and all clovers from English seed, have proved more vigorous and lasting than the same kinds grown from imported seed; the clovers succumb readily to "clover sickness," which is very troublesome here, and usually attacks the plants after the first crop of "seeds" hay has been mown. In 1909, after a wet and cold spring, the clover plants died off before producing a crop of herbage, and the "sickness" was then found to be due to stem eelworm (*Tylenchus devastatrix*).* This parasite also causes "tulip-root" in oats. No traces of the fungus, *Sclerotinia trifoliorum*, were found on any of the diseased plants, a fungus so often associated with this disease.

(7) Cowgrass clovers (varieties of red clover) have not done as well as ordinary red clover. The true singlecut cowgrass has, however, given excellent results, and Swedish red clover of this type has done fairly well. (See *Journal of the Board of Agriculture* for April, 1919).

(8) Alsike clover has not been a success, either for first or second year's hay. Many Tweedside agriculturists, however, claim that it resists "clover sickness" more successfully than ordinary red clover.

(9) Trefoil or yellow clover grows successfully, but has two disadvantages when used in a seeds mixture; it matures more quickly than the other clovers and grasses of the mixture, and has lost much of its nutriment before it is harvested; it also grows very rapidly in the early summer and tends to choke out the other clovers.

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* See Ministry of Agriculture leaflet, No. 46.

(10) Ordinary white clover seed does not produce lasting plants, but *wild white clover seed* does so.

(11) Clovers can be easily choked out by grasses when the latter are grown in excessive quantity.

Seeds mixtures for one year.—For results for the years 1908–1913 see *Guide* for 1915, and for the years 1914–1919 see Guide for 1921.

Seed mixtures per acre for one year were sown in the spring of 1920 on plots 1/6th acre in area with barley and wheat in East Tower Hill Field (N).

	Cost of seed per lb. 1920.	Plot 1. lb.	Plot 2. lb.	Plot 3. lb.	Plot 4. lb.
Perennial ryegrass	6d.	18	18	18	18
Cowgrass (true singlecut) ...	5/-	5	—	—	5
Colonial cowgrass	5/- ?	—	5	—	—
English red clover	4/-	—	—	5	—
Alsike clover	3/6	1	1	1	1
Trefoil	1/6	2	2	2	2
Wild white clover	30/-	½	½	½	—
Cost of seed per acre ...	...	55/6	55/6	50/6	40/6
Weight of hay per acre, 1921	...	38¼	32¼	29½	43¼

Seed mixtures per acre for one year were sown in the spring of 1921 on plots 1/6th acre in area with barley in East Tower Hill Field.

	Plot 1. lb.	Plot 2. lb.	Plot 3. lb.	Plot 4 lb.
Perennial ryegrass	18	18	9	18
Italian ryegrass	—	—	9	—
Cowgrass (true singlecut) ...	5	—	5	5
English red clover	—	5	—	—
Alsike	1	1	1	1
Trefoil	2	2	2	—
Wild Trefoil	—	—	—	2
Wild white clover	½	½	½	½

The remainder of the land is sown down with the mixture used for plot 1.

The seeds mixture sown in the spring of 1922 on barley in Back House Field (S.E.) was as follows:—18 lb. perennial ryegrass, 5 lb. true singlecut cowgrass, 2 lb. trefoil and ¼ lb. wild white clover.

All the seeds mixtures for one year receive 5 cwt. high grade basic slag per acre.

For one year's seeds, the inclusion of wild white clover has given excellent results at Cockle Park. When this is included, an excellent and close clover aftermath has been produced, while the corn crop that follows is greatly benefited by the growth of clover root.

Seeds mixtures for three or more years.—The laying away of land for old land hay or for pasture has always been a difficult problem, and in the past there has usually been a considerable period to bridge over from the time that the plants fail until natural herbage has developed. Further, the ordinary cultivated clovers which under suitable conditions, may do well for one or two years, usually fail after that time.

This problem has been dealt with at Cockle Park by noting which plants when sown continued to produce abundant and nutritive herbage for some years afterwards. The plants which have failed to do so are eliminated from the seeds mixtures.

It has been found advisable to lay away some of the thin, poor clay soil lying on Boulder Clay. It has also been found advantageous to leave the "seeds" down for three years on the land of this character under rotation.

The following seeds mixtures were sown in Tower Hill Field (E) in the spring of 1906, on plots ¼ acre in area, on a poor and stiff clay of low value.

Seeds Mixtures an Acre for Three or More Years.

Results* per acre, 14 years, 1907-1921.

	Cost of seed.		Plot 1. lb.	Plot 2. lb.	Plot 3. lb.	Plot 4. lb.
Perennial ryegrass ...	2⅔d.	per lb.	6	6	—	—
Italian ryegrass	3½d.	,,	6	6	6	—
Cocksfoot...	9d.	,,	6	6	22	12
Timothy	3½d.	,,	3	3	—	3
Meadow fescue	11d.	,,	8	8	—	6
Tall fescue	1/-	,,	—	—	—	4
Tall oat grass	8d.	,,	—	—	—	4
English red clover ...	8¾d.	,,	4	4	—	4
Alsike	9½d.	,,	2	2	—	—
White clover	8d.	,,	4	4	—	—
Wild white clover ...	1/6	,,	—	4	—	4
			39	43	28	37
Cost of seeds an acre			23/-	29/-	18/3	31/-
Weight of hay an acre.			cwt.	cwt.	cwt.	cwt.
Twelfth year, 1919			19¾	24¼	19½	24½
Thirteenth year, 1920			27¼	26¼	22	26¼
Fourteenth year, 1921			19	20	18¾	15½
Average			**20¾**	**27¾**	**17½**	**25¼**

* The results for each year since 1907 are given in the Guide for 1921.

Effects of Manures on the yield of hay from different seeds mixtures, 1907 to 1920.*

(The manures were applied in November, 1906, again in November, 1909, in November, 1912, in November, 1915, again November, 1918, and again November, 1921.)

		Cross plots.			
		A=⅓ acre	B=⅓ acre	C=⅙ acre	D=⅙ acre
		10 cwt. slag. 200 lb. phos. ac.	10 tons dung.	10 cwt. slag. 10 tons dung.	No manure.
		cwt.	cwt.	cwt.	cwt.
Plot 1.	1907	39½	28½	38	6¾
	1908	23½	18½	20¾	5¼
	1909	15¾	16½	19¾	8
	1910	16¼	19½	19	4¾
	1911	18¼	19¾	14½	4½
	1912	25½	21	18½	13
	1913	25¼	20	31¼	3½
	1914	22	23	29¾	5
	1915	10½	18½	15	1½
	1916	37	39¼	36¼	4½
	1917	23	24½	31½	8
	1919	20½	23½	19¾	11¼
	1920	32¾	27½	39½	3¼
	Average (13 years)	**23¾**	**22¾**	**25½**	**5¼**
Plot 2.	1907	38	38	38½	18
	1908	33½	33¼	26	9¾
	1909	25½	22¼	24½	11
	1910	39¾	33	35¾	11½
	1911	30¼	28¾	24¼	9
	1912	51	32¼	46¼	13½
	1913	35	29	33	4½
	1914	34¾	35¾	36¾	11
	1915	23½	24	34¾	2¾
	1916	35½	37¼	36¼	3¾
	1917	29	26¼	30¼	9½
	1919	23	25¾	31¾	15¾
	1920	25½	29½	43¾	4¼
	Average (13 years)	**32½**	**29¾**	**33¾**	**9¼**
Plot 3.	1907	4	8¼	6¾	4¾
	1908	8¼	8	10¼	4½
	1909	11½	9¾	10¾	5¼
	1910	13	13	18½	7½
	1911	15¾	21	12¾	6
	1912	21¾	22	19¾	7¾
	1913	20¾	16½	21¾	2¾
	1914	29¼	28¼	33¾	7½
	1915	11¼	11	14¾	2
	1916	42¼	40½	40½	6¼
	1917	26¼	21¾	30¼	10¼
	1919	19¾	20¼	22¾	13¾
	1920	17¾	27¾	35½	8¾
	Average (13 years)	**18½**	**19**	**21⅓**	**6¾**
Plot 4.	1907	35¼	25½	25½	4½
	1908	39½	33½	23½	10½
	1909	29½	21¾	16½	9½
	1910	28¾	23	27¼	11½
	1911	31½	23½	21	8¾
	1912	47½	25	44½	19¼
	1913	35	29¼	39	5
	1914	33½	34¼	34¼	11¾
	1915	21	13½	19½	2¾
	1916	36	36¾	33¾	3¼
	1917	35¼	24½	36½	9
	1919	23½	28½	30	13½
	1920	29½	28¾	33¼	5¾
	Average (13 years)	**32¾**	**26¾**	**29½**	**8½**
Average annual cost of manures		13/-	25/-	38/-	—

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* The hay from these plots was not weighed in 1918, owing to shortage of labour.

Undoubtedly *wild white clover* has proved the most valuable plant in the seeds mixtures. On the two plots where this was sown a remarkable carpet of white clover was quickly developed. On plot 1 ordinary white clover practically failed to produce plants. The seed of wild white clover is produced from true wild white clover plants. The late Mr. Thomas Rigby, of Cheshire, about 1890, demonstrated at Hawarden that the seed of true wild white clover was much better suited for the laying down of permanent pasture than the seed of common white clover.

Cocksfoot grass did badly at first when sown alone on plot 3, but did better on the other plots, especially when associated with wild white clover. The stronger and darker green cocksfoot when grown with clover, was very evident as early as June, 1907, and shows that grasses very quickly benefit from association with clovers, no doubt owing to the nitrogen collected by the latter.

The absence of the quick growing ryegrasses on plot 4 allowed the clovers to develop much better.

The seeds mixture on plot 2 has been the most profitable. Common white clover and meadow fescue might have been omitted, and this would have reduced the cost of this mixture.

The slag applied on the young seeds for 1907 greatly developed the clover plants, this being evident within four months of its application. On the cocksfoot plot, where no clovers were sown, colonies of natural white clover have developed from native plants of white clover, especially where slag was applied.

Dung has greatly increased ryegrass, cocksfoot, and other grasses, but in doing so has checked the clovers. Wherever wild white clover was sown, slag gave heavier crops of hay than dung. Slag alone has given more hay than slag and dung together, probably because dung, in developing the grasses, tended to repress the clovers.

About three acres of poor stiff clay soil at the south-west corner of Tower Hill Field were summer fallowed in 1906 and sown with wheat for 1907. On this land the seeds mixture sown on plot 2, (page 41) was sown in the spring of 1907 for hay for three or more years. Basic slag was applied at the rate of 10 cwt. an acre in the autumn of 1907, in November, 1910, in November, 1913, in November, 1916, and again in November, 1919. There has been produced, per acre, 28 cwt. hay in 1908, 31 cwt. in 1909, 36 cwt. in 1910, 30 cwt. in 1911, $55\frac{1}{2}$ cwt. in 1912, 52 cwt. in 1913, 34 cwt. in 1914, $20\frac{1}{2}$ cwt. in 1915, $50\frac{1}{2}$ cwt. in 1916, and 39 cwt. for 1917, an average of $37\frac{3}{4}$ cwt. for 10 years. Valuable aftermath, rich in clover, has also been grown in each year. Three plots each $\frac{1}{6}$th acre in area have been marked off and treated as follows in November, 1913, in 1916, and in 1919, the previous treatment of all the plots being as indicated above.

		Weight of hay per acre.			
		1914. cwt.	1915. cwt.	1916. cwt.	1917. cwt.
Plot 1 ...	10 cwt. basic slag (200 lb. P_2O_5). ...	**$34\frac{1}{4}$**	**$20\frac{1}{2}$**	**$50\frac{1}{2}$**	**39**
Plot 2 ...	10 cwt. basic slag and 2 cwt. muriate of potash (50% K_2O).	**35**	**$21\frac{1}{4}$**	**$46\frac{1}{4}$**	**31**
Plot 3 ...	Untreated...	**$29\frac{1}{4}$**	**$13\frac{1}{4}$**	**$38\frac{1}{2}$**	**$29\frac{3}{4}$**

The N.W. corner of this field was sown down for 1918, and received 10 cwt. an acre of basic slag (39% phosphates) every third year, commencing 1918.

The results of different seeds mixtures sown on the north-west portion of Back House Field are given in the Guide for 1921.

The results of three years' seeds mixtures, sown annually from April, 1910, till April, 1914, are given in the Guide for 1918, and for April, 1915, till April, 1917, in the Guide for 1921.

The following three years' mixtures an acre were sown in May, 1918, on barley land in Upper Brick Field. All the plots are $\frac{1}{6}$th acre in area.

	Cost of seed per lb. 1918.	Plot 1. lb.	Plot 2. lb.	Plot 3. lb.	Plot 4 lb.
Perennial ryegrass	4d.	16	16	16	16
Cocksfoot (English grown) ...	2/6	10	—	—	10
Cocksfoot (Danish)	2/6	—	10	—	—
Cocksfoot (Svalöf)	2/6?	—	—	10	—
Timothy	10d.	4	4	4	4
Cowgrass (true single-cut) ...	3/5	4	4	4	4
Suckling clover	1/3	2	2	2	—
Trefoil	10d.	1	1	1	1
Wild white clover	16/6	1	1	1	1
Cost of seed per acre, 1918 ...		67/2	67/2	67/2	64/8
Weight of hay per acre,					
1919 (cwt)		$31\frac{3}{4}$	$26\frac{1}{2}$	$27\frac{3}{4}$	$35\frac{3}{4}$
1920 (cwt)		$41\frac{1}{2}$	$37\frac{1}{2}$	$38\frac{3}{4}$	37
1921 (cwt)		$25\frac{3}{4}$	$27\frac{1}{2}$	$26\frac{3}{4}$	$28\frac{3}{4}$
Average		**33**	**$30\frac{1}{2}$**	**31**	**$33\frac{3}{4}$**

The following three years' mixture an acre was sown on April 22nd, 1919, on wheat in the middle of Mid Tower Hill Field, and on barley on the Small Farms. This mixture was also sown on oats in

West Tower Hill Field and in Lower Brick Field (E.), on land ploughed out from old turf for 1918 and 1917 respectively.

	lb.	Cost of seed per lb.
Perennial ryegrass	16	6d.
Cocksfoot (Danish)	10	1/6
Timothy	4	1/10
Cowgrass (true single-cut)	4	6/7
Trefoil	1	1/2
White wild clover...	1½	18/-
Cost of seed per acre, 1919		84/10

The following three years' mixtures an acre were sown in May, 1920, on barley land in Upper Brick Field (E.) All the plots are ⅙th acre in area.

	Cost of seed per lb., 1920.	Plot 1. lb.	Plot 2. lb.	Plot 3. lb.	Plot 4. lb.	Plot 5. lb.	Plot 6. lb.	Plot 7. lb.
Perennial ryegrass (Ayrshire)	6d.	16	—	16	16	16	26	16
Hawkes Bay ryegrass	6d. ?	—	16	—	—	—	—	—
Cocksfoot (Danish) ...	1/8	10	10	—	10	10	—	—
Akaroa Cocksfoot (New Zealand)	1/8 ?	—	—	10	—	—	—	—
Cocksfoot (English), grown in Gloucestershire at an altitude of 850 feet ...	1/8 ?	—	—	—	—	—	—	10
Timothy (American) ...	1/-	4	4	4	4	4	—	4
Cowgrass (true single-cut)	5/-	4	4	4	—	—	4	4
Colonial cowgrass ...	5/- ?	—	—	—	4	—	—	—
English Red Clover ...	4/-	—	—	—	—	4	—	—
Trefoil	1/6	1	1	1	1	1	1	1
Wild White Clover ...	30/-	1½	1½	1½	1½	1½	1½	1½
Cost of seed per acre, 1920 ...		95/2	95/2	95/2	95/2	91/2	79/6	95/2
Weight of hay per acre, 1921 (cwt)		51	43¾	53¾	34¼	34½	49¾	46¼

The remainder of the land in Upper Brick Field, together with 4½ acres in Lower Brick Field (W.), and 5 acres comprised of the Small Farms and land below, is sown down with the mixture used on plot 1.

The following three years' mixtures an acre were sown on April 29th, 1921, in Lower Brick Field on barley. All the plots are ⅙ acre in area.

	Plot 1. lb.	Plot 2. lb.	Plot 3. lb.	Plot 4. lb.	Plot 5. lb.	Plot 6. lb.
Perennial ryegrass	16	16	—	—	—	—
Wild ryegrass	—	—	16	26	26	26
Cocksfoot	10	10	10	—	—	—
Timothy	4	4	4	—	—	—
Cowgrass (true single cut) ...	4	4	4	—	—	—
Wild red clover	—	—	—	—	6	—
Trefoil	1	1	1	5	—	—
Wild trefoil...	—	—	—	5	—	—
Wild white clover	1½	—	1½	1½	—	3
Wild white clover (New Zealand)	—	1½	—	—	—	—

The remainder of the barley land in Lower Brick Field is sown down with the mixture used on Plot 1.

The following three years' mixtures an acre were sown on April 19th, 1922, in Backhouse Field (N.W.) on barley. All the plots are $\frac{1}{6}$ acre in area.

	Plot 1. lb.	Plot 2. lb.	Plot 3. lb.	Plot 4. lb.	Plot 5. lb.	Plot 6. lb.
Perennial ryegrass	16	—	—	—	16	16
Wild ryegrass	—	16	26	26	—	—
Cocksfoot (New Zealand)... ...	10	10	—	—	—	—
Cocksfoot (Danish)	—	—	—	—	10	—
Tall oat grass	—	—	—	—	—	20
Timothy	4	4	—	—	4	4
Cowgrass (true singlecut) ...	4	4	4	—	4	4
Wild red clover	—	—	—	6	—	—
Trefoil	1	1	1	—	1	1
Wild white clover	1½	1½	1½	—	1½	1½

The remainder of the land is sown down with the mixture used on Plot 1.

High grade basic slag, 10 *cwt. an acre, is applied to all young seeds for three years' ley in the November after they are sown.*

VARIETIES OF MANGELS, 1905-15.—See Guide, 1921.

Manuring of mangels, East Tower Hill, commencing 1908.—For a full account of the trials for 1908–18 see Guide for 1921.

Salt for mangels.—On the average of the first five years, salt increased the mangel crop by over 3¾ tons an acre.

A portion of each of six of the permanent mangel plots received 2 cwt. common salt an acre for 1907, applied in the drills at the time of sowing the crop. On the average 28.2 tons of mangels were grown an acre where salt was applied, and only 21.3 tons when salt was not applied. See Cockle Park Guide for 1908, page 49.

Effects of lime on mangels.—Both lime (2 tons an acre) and lime mud (4 tons an acre) have been tried on eight of the mangel plots, the dressings being applied in the spring of 1906. Lime decreased the quantity of roots on the average by 2½ tons an acre in the two following years, while lime mud did so to the extent of about 4½ tons an acre. See Cockle Park Guide for 1908, page 49.

Manuring of mangels, East Tower Hill, commencing 1917.—In East Tower Hill Field (S.E.) the following plots of Mammoth Long Red mangels were started in 1917, each being 1/8th acre in area. There are 6 drills in each plot and each drill is 130 yards long by just over 27 inches wide. Plot 1 is to the east. There are two drills to the east not under experiment.

Plot.	Manures per acre.	Annual cost of manures.	Weight of roots.				Average annual Increase over plot 6b.		Value of annual increase over plot 6b at 15/- per ton.
			1921.		Average of five years 1917-1921.				
		s. d.	Tons.	Cwt.	Tons.	Cwt.	Tons.	Cwt.	s. d.
1 (to east)	12 tons dung, 2 cwt. sulphate of ammonia, 3 cwt. high grade slag, 2 cwt. common salt	137/8	32	12	28	8	**12**	**15**	**191/3**
2	As for plot 1, but 4 cwt. sulphate of ammonia	169/8	31	15	27	7	**11**	**14**	**175/6**
3	As for plot 1, but 4 cwt. common salt	141/8	30	16	26	3	**10**	**10**	**157/6**
4	As for plot 1, but 2 cwt. muriate of potash	165/2	31	8	26	1	**10**	**7**	**155/3**
5	As for plot 1, but 2 cwt. nitrate of soda in two top-dressings	173/8	31	5	26	18	**11**	**5**	**168/9**
6a	12 tons dung (3 drills) ...	90/-	25	12	22	4	**6**	**11**	**98/3**
6b	No manure (3 drills)	...	19	8	15	13	..		...

All the manures except nitrate of soda, were applied in the drills. Mammoth Long Red mangels were sown on May 2nd. The mangel seed (8 lb. an acre) was steeped in water for twenty-four hours and dried in the sun before sowing.

Mangels after Oats.—In 1920 an additional twelve drills of mangels after oats were sown to the west of the plots given in the table above. The manuring was as for plot 1. On six of these drills Prize Winner Yellow Globe was sown, while on the other six, Mammoth Long Red were sown.

The results were as follows:—

1. Mammoth Long Red gave just under 2 tons an acre more mangels than those grown on the regular mangel land.

2. Mammoth Long Red yielded 7 tons 2 cwt. an acre more mangels than did Prize Winner Yellow Globe.

In 1921 to the west of the plots of the table were two drills not under experiment on the old mangel land, followed by three drills of Mammoth Long Red, three drills of Golden Tankard from a specially selected non-bolting strain, three drills of Prize Winner Yellow Globe, and three drills of ordinary Golden Tankard, on the land which in 1919 was sown with oats. These were sown on April 29th, and manured with the standard dressing for plot 1 given above. The results an acre were as follows: Mammoth Long Red, 28 tons; Golden Tankard (non-bolting) 19 tons 6 cwt; Prize Winner Yellow Globe, 33 tons 13 cwt; and Golden Tankard (ordinary) 19 tons 9 cwt.

This year to the east of the plots are two drills not under experiment, then follow three drills of each of the varieties named in the preceding paragraph, sown in the same order as for last season. An additional trial of the non-bolting and ordinary strains of Golden Tankard is being made in Palace Leas Field on four drills, next to the trials of potatoes. These were sown on April 21st.

Manures for cabbages.—From trials at Cockle Park it may be assumed that 10 to 12 tons dung, 1½ cwt. sulphate of ammonia, and 4 cwt. basic slag, all applied in the drills, will make a good dressing an acre for cabbages. Common salt (2 cwt. an acre) has considerably increased the crop over a period of eight years.

TRIALS OF VARIETIES OF POTATOES.

Trials with potatoes have been conducted for several years. In 1905 a bulletin on "Why Potatoes Vary in Cropping Power" was published, and since that time annual summaries of the results have appeared in the Guides.

Results 1919, 1920 and 1921.—The potatoes were grown on a sandy loam soil in East Tower Hill Field in 1919 and 1920, and in Upper Brick Field in 1921, in drills 30 inches wide. The sets were all whole, of medium size, and were planted on April 17th in both years, 15 tons dung an acre being applied at the time of planting. The preceding crop was oats.

Varieties of potatoes.—Results per pole. (Stones per pole = tons per acre).

Variety.	Source of seed.	Year.	Weight of tubers.					
			1919.		1920.		1921.	
			Large. stones	Total. stones	Large. stones	Total. stones	Large. stones	Total. stones
Arran Rose	Scotland	1919	**2½**	4½	**6¾**	7	**11½**	6¾
Dargill Early	Scotland	1920	...	...	**4¾**	4¾	**12½**	6¾
Witch Hill Early	Scotland	1920	...	...	**7¾**	7¾	**12**	6¾
Arran Comrade	Scotland	1920	...	...	**9**	10	**23¾**	14¾
Elite	Scotland	1920	...	...	**6½**	7	**22¼**	12¾
British Queen	Scotland	1918	**5½**	7½	**10½**	11¼	**22**	13½
King Edward	Dunbar	1917	**5¼**	7¼	**10¼**	11¼	**20¾**	13¼
Great Scot	Scotland	1917	**6**	7½	**11**	11½	**24¼**	13½
King George	Scotland	1918	**6**	7¼	**10¾**	11¼	**23¼**	13
Ally	Scotland	1918	**5½**	7½	**9**	9½	**21**	12
Cumberland Ideal	Scotland	1918	**3¾**	5¾	**10½**	11	**25½**	14
Arran Chief	Scotland	1918	**6½**	8½	**11**	11¼	**26¼**	14¾
Arran Chief	Scotland (peaty soil)	1918	**5**	7	...	...	...	...
Kerr's Pink	Scotland	1918	**7**	10	...	...	...	...
Kerr's Pink	Scotland	1919	**5¾**	10¼	**12¾**	13¼	**28½**	15¼
Dobbie's Prolific	Scotland	1918	**6½**	8½	**11¾**	12½	**20¼**	11
Templar	Durham	1918	**5¼**	7½	**14¼**	14¾	**24½**	13½
Templar	Scotland	1919	**4¾**	7½	...	...	...	...
Scottish Farmer	Durham	1918	**4½**	6½	...	...	...	...
Lochar	Scotland	1919	**6¾**	10	**12¾**	13¾	**24½**	14¼
Nithsdale	Scotland	1919	**2½**	4¾	**10**	11	**15¾**	11¼
Bishop	Scotland	1919	**5**	6½	**9**	9¾	**18½**	10½
President	Scotland	1920	...	...	**10**	10½	**21**	11½
Tinwald Perfection	Scotland	1920	...	...	**11¾**	12¼	**16½**	9
Majestic	Scotland	1920	...	...	**11½**	12	**24**	13½

Tubers from different soils and districts.—It has been conclusively shown at Cockle Park that potatoes from Scotland or from the North of Ireland give considerably better results than when they are grown for more than one year at Cockle Park. Only a quarter of a crop was given when Up-to-date potatoes came from a light gravelly soil in Berkshire. Probably this result is explained by the fact that potato tubers become much more mature in the drier climate and longer summer of the South of England, and that when this is so their productive power is greatly reduced.

Sprouting before planting.—When the potatoes were sprouted before planting increases of more than a ton of good potatoes an acre were obtained than when the tubers were unsprouted. These results were with main crop and late varieties, and not early varieties, the good effects of planting the latter with sprouted seed being already well known.

The manuring of potatoes.—Excellent results have been given by the application of 12 tons dung an acre applied in the drills at the time of planting. Although the potatoes received dung alone directly, they also benefit from the residue of the artificial manures applied to the seeds hay. Rather larger crops would be grown if artificials were added to the dung, and it has been found in the College experiments throughout the district that the following makes a useful dressing per acre, all applied at the time of planting:—10 to 12 tons dung, 1 cwt. sulphate of ammonia, 2 cwt. basic slag, 1½ cwt. superphosphate. This, of course, would be modified to suit local conditions.

Good hand and horse cultivation is carried out as long as it is possible to do so, and then the potatoes are moulded as high up as possible by a double mouldboard plough.

Varieties of potatoes, 1922.—The following varieties of potatoes were planted on April 19th, in Palace Leas Field, in drills 30 ins. wide; they were whole and of medium size. The soil is a medium loam, and the preceding crop was oats. Dung was applied, 15 tons to the acre, at the time of planting. The plots are each $\frac{1}{80}$th acre (two poles) in area.

Second early varieties.

No.	Variety.	Source.	Distance between sets.
1.	—Arran Comrade	Scotland, 1922.	14 inches.
2.	—King George	Scotland, 1922.	14 ,,
3.	—British Queen	Scotland, 1922.	14 ,,
4.	—King Edward	Scotland, 1922.	14 ,,
5.	—Ally	Scotland, 1922.	14 ,,

Maincrop and late varieties.

No.	Variety.	Source.	Distance between sets.
6.	—Tinwald Perfection ...	Scotland, 1922.	16 ,,
7.	—Lochar	Scotland, 1922.	16 ,,
8.	—Kerr's Pink	Scotland, 1922.	16 ,,
9.	—Irish Chieftain	Scotland, 1922.	16 ,,
10.	—Templar	Scotland, 1922.	16 ,,
11.	—Up-to-Date	Scotland, 1922.	16 ,,
12.	—Arran Chief	Scotland, 1922.	16 ,,
13.	—Majestic	Scotland, 1922.	16 ,,
14.	—Rhoderick Dhu	Scotland, 1922.	16 ,,
15.	—Crusader	Scotland, 1922.	16 ,,
16.	—President	Scotland, 1922.	16 ,,

North of the variety trials there are three drills on which Leaf Curl trials are being made on Arran Comrade potatoes.

Plot 17.	Free from Curl	Scotland, 1922.
,, 18.	Free from Curl	Scotland, 1921.
,, 19.	Affected with Curl	Scotland, 1921.

Further to the north are six drills of Kerr's Pink potatoes; to the south (next to the road) seven drills of Lochar potatoes; and at the east end of the variety trials Templar potatoes are planted.

Varieties of Swedes and Turnips, 1915-18.—See Guide, 1921, for full results.

VARIETIES OF SWEDES AND TURNIPS, 1921; RESULTS PER ACRE.

Variety	Weight of roots.		Dry matter.	Weight of dry matter.	Number of roots per acre.
SWEDES.	T.	C.	%	TONS.	
Improved (bronze top)	24	0	10·34	**2·48**	25,600
Caledonian (bronze top)	23	17	10·04	**2·39**	20,960
Up-to-date (bronze top)	24	12	10·20	**2·51**	23,280
Champion (purple top)	22	18½	10·40	**2·39**	23,520
Magnum Bonum (purple top)	22	2¾	11·08	**2·55**	23,280
New Buffalo (purple top)	23	2	11·06	**2·55**	22,000
Conqueror (bronze green top)	20	13½	10·38	**2·15**	24,000
Darlington (bronze top)	24	10	9·61	**2·35**	22,240
TURNIPS.					
Green Top Aberdeen	11	12	8·44	**0·98**	21,200
Perfection Green Top Aberdeen	18	13½	7·40	**1·36**	20,480
Large Improved Green Top	18	0	7·47	**1·34**	21,360
Purple Top Aberdeen	16	18½	8·30	**1·40**	20,160
Favourite Purple Top Aberdeen	20	14¼	7·87	**1·63**	29,120
SOFT TURNIPS.					
Early Sheepfold (green top yellow)	20	9¼	7·70	**1·58**	24,000
Selected Fosterton (green top yellow)	17	7	8·05	**1·40**	20,320
Centenary (green top yellow)	20	4¼	6·59	**1·34**	21,600
Purple Top Mammoth (white)	28	8½	6·03	**1·71**	20,480
Pomeranian White Globe	28	5	7·27	**2·05**	22,080

Average percentage of dry matter in swedes at Cockle Park.—The average percentage of dry matter in swedes in 1900 was 11.43; 1901, 10.32; 1902, 11.93; 1903, 11.67; 1904, 14.96; 1905, 12.09; 1906, 12.12; 1907, 11.51; 1908, 10.85; 1909, 12.34; 1910, 11.76; 1911, 11.29; 1912, 13.21; 1913, 11.94; 1914, 10.98; 1915, 12.06; 1916, 12.08; 1917, 13.02; 1918, 11.00; 1919, 12.33; 1920, 10·54; 1921, 10.24. These show how greatly the feeding value of swedes varies from season to season. The average percentage of dry matter in swedes is practically 12% at Cockle Park. In 1904, 20 cwt. swedes had as much feeding value as 29¼ cwt. in 1922.

VARIETIES OF SWEDES AND TURNIPS, 1922.

Swedes.—Two drills each of the following swedes were sown in Backhouse Field (S.W.) on May 4th. Improved bronze top, Up-to-date bronze top, Caledonian bronze top, Champion purple top, Magnum Bonum purple top, New Buffalo purple top, Conqueror bronze top.

Turnips.—Four drills each of the following turnips were sown in Upper Brick Field on May 11th. Green Top Aberdeen, Perfection Green Top Aberdeen, Large Improved Green Top, Purple Top Aberdeen, Favourite Purple Top Aberdeen.

Soft Turnips.—Four drills each of the following soft turnips were sown in Backhouse Field (S.W.) on May 16th. Early Sheepfold (green top yellow) Selected Fosterton (green top yellow), Centenary (green top yellow), Purple Top Mammoth (white), Pomeranian White Globe (white).

Caledonian Bronze Top swedes and Favourite Purple Top Aberdeen yellow turnips are being grown on the ordinary land. The roots at Cockle Park receive 15 tons of dung an acre.

Steeping the turnip seed in paraffin or in turpentine for about two hours before sowing probably helps to keep the fly from the seedlings for a short time after germination. The seed should be dried in the sun or otherwise, before sowing.

Town refuse manure compared with farmyard dung.—On $\frac{1}{3}$ acre plot 5 tons of specially pulverised manure, prepared by Gateshead Corporation, were applied on swedes on the N.E. of Backhouse Field (N.W.). This was compared with 15 tons an acre of ordinary dung, which is the usual quantity applied for roots at Cockle Park. This corporation manure is rich in material from dry closets. The results were, from the pulverised manure 21 tons 8 cwt., and from ordinary dung 25 tons 4 cwt. roots an acre.

UPPER BRICK FIELD FINGER-AND-TOE PLOTS.

A full account of the results of these plots is given in the Guide for 1916. These show that any of the following dressings per acre, applied once in a four or six course rotation, will in the long run effectually check this disease:—2 tons ordinary lime; 2 tons ground lime; 4 tons lime mud. A report on Lime and Its Uses in Agriculture, dealing fully with this subject, can be had on application from Agricultural Department, Armstrong College, Newcastle-upon-Tyne.

THE MANURING OF LAND NOT UNDER EXPERIMENT AT COCKLE PARK.

The poor clay pasture land is now being treated as follows:—A first dressing of 10 cwt. basic slag (200 lb. phosphoric acid) is applied an acre, and half this quantity is applied every three years thereafter. It is found that a potash manure is not necessary on the clay soil, and that a nitrogenous manure, like nitrate of soda, gives pasture of poorer feeding quality. As slag develops leguminous herbage and the latter collects nitrogen from the air, a manure containing nitrogen is not needed. It is only where the pasture is lying on light sandy soil that a potash manure may increase the effect of the slag.

For old land hay 5 cwt. basic slag (100 lb. phosphoric acid) an acre is applied every three years, and a light dressing of dung is also given every three or four years. Topdressings in spring of nitrate of soda or sulphate of ammonia are strictly withheld, as they tend to check clover herbage and consequently the collection of nitrogen from the air by these plants. Even on the sandy soils a potash manure is not needed with this treatment as the dung supplies sufficient potash.

The sandy soil under a four-course rotation is manured as follows an acre:—Turnips or potatoes, 15 tons dung (applied in drill); barley, no manure; grass and clover hay, 5 cwt. basic slag (100 lb. phosphoric acid) and 1 cwt. muriate of potash* (50% potash) (applied after barley harvest); oats, no manure. On the clay loam soils the rotation is extended to six years by taking seeds hay for three years instead of one. Roots receive 15 tons dung; barley, no manure; grass and clover hay, 10 cwt. basic slag (200 lb. phosphoric acid) applied after barley harvest; oats, no manure. On the clay loam soils a potash manure is not necessary, and 10 cwt. slag proves an excellent and sufficient manuring for the three following hay crops. Last autumn equivalent dressings of mineral phosphate have been largely used in place of high grade basic slag on both temporary and permanent grass. Occasionally some of the stiffest clay is summer fallowed, instead of being put into roots, after which wheat is grown, which receives a dressing of dung. These systems of treatment are giving quite satisfactory results on two of the leading types of arable soils to be found in the County of Northumberland. It should further be noted that 4 tons an acre of lime mud are always applied to the hay stubble before ploughing.

* Not now applied and no serious disadvantage.

FORESTRY.

In the southern portion of Broomy Hill, ten plots of ground have been laid off and planted with forest trees for the purpose of illustrating certain principles of sylviculture. Plots 2-8 are each about half-an-acre, and the three remaining plots somewhat less. The trees were set out in triangles $3\frac{1}{2}$ feet apart. Plots 1-7 were planted in the spring of 1898, and plots 8-10 in the spring of 1899. The trees were "pitted" in plots 6, 9, and 10, and "notched" in the other sections.

Plot 1.—**Norway Spruce and Ash.**—Represents a mixture of shade-bearing and light-demanding species. The spruce has done well, but the ash has probably been checked by late frosts.

Plot 2—**Pure Scotch Pine.**—Represents a pure wood of "light" trees, and is doing well.

Plot 3—**Oregon and Colorado** varieties of the **Douglas Fir** in alternate rows. The growth of this plot has been very irregular, probably due to the wet and stiff soil.

Plots 4 and 5—**Sitka Spruce and Norway Spruce** unmixed, the intention being to grow pit-wood on a 30-40 years' rotation, and not to thin hurriedly. Both plots are doing well, but the Sitka spruce gives clear indication of being a much more rapid grower than the common species in this locality.

Plot 6—(*a*) **Beech, German Larch and Scotch Pine**—(*b*) **Beech and Oak.**—Both examples of mixtures of "light" and "shade" trees.

Plot 7—**European Larch from Scotch and German Seed and Japanese Larch.**—In alternate rows, representing a wood of light-demanding trees. In this plot the Japanese larch has far outstripped the European variety. It has also retained its leading shoot better than is usually the case with this species. Of the European trees, the plants raised from Scotch seed are larger and more vigorous than those raised in Germany, but both suffer greatly from the larch aphis.

Plot 8—**Norway Spruce and German Raised Larch.**—Planted for comparison with plot 7.

Plots 9 (*a*) and 10 (*a*)—A mixture of **Japanese and German Raised Larch with Silver Fir**.—Representing a "light" and "shade" mixture. The soil of 10 (*a*) received 16 cwt. of basic slag before planting, and the growth of the silver fir has apparently been increased by this dressing.

Plot 9 (*b*)—Originally planted with black Italian poplar, which gradually died out. Replanted in spring of 1906 with **Japanese Larch and Douglas Fir**. The larches are already outstripping the Douglas firs, which are from Oregon seeds.

Plot 10 (*b*)—Originally black Italian poplar with silver fir. The former has been replaced by *Pinus laricio* (Corsican pine).

Probably the most remarkable feature of the demonstration plots is the extraordinarily successful growth of the Japanese larch in the poor clay soil. Up to the present, not only have they far outstripped the European larch in point of rapidity of growth, but they are entirely free from aphis attack, and nowhere is there any appearance of that fell disease, the larch canker, so prevalent in the European species.

Another marked feature of these plots is the rapid growth of the Sitka spruce as compared with the Norway spruce.

The foregoing plantations are protected on the west side by a shelter belt of Scotch pine 20 yards wide. The shelter belt is divided into eight sections, each of them 40 yards long, which have been planted in the following manner:—

Sections A and E—Trees planted in pits 12 in. by 12 in.
,, B ,, F—Trees planted in T-shaped notches.
,, C ,, G—Turfs 15 in. by 15 in. removed, soil stirred with pick, trees planted and turfs slit, inverted, and replaced.
,, D ,, H—Planted in the same way as last, except that the soil was stirred by means of a special German implement.

A small arboretum has been formed on the S.E. corner of Broomy Hill, consisting of conifers and a few deciduous trees. Three trees of each species were planted in close proximity with the view of removing two and leaving the best. The trees were re-arranged during the spring of 1905, and a considerable number were added in the spring of 1912.

HORTICULTURE.

Among the horticultural features is a fruit plot, about $\frac{1}{3}$ acre in area, laid down over 20 years ago. About one-fourth of this is good garden soil, while the remainder is clayey in character and anything but ideal for fruit culture.

Trial of Varieties.—Apples, of which nearly 50 varieties have been tried, have always preponderated. Comparatively few have proved suitable to the prevailing conditions. Dessert sorts are the least satisfactory. They blossom and set their fruit but fail in respect to size, colour and flavour. Canker has proved very troublesome.

The following is a list of the most successful varieties placed approximately in their order of merit in respect to cropping qualities:—

Lane's Prince Albert	K.	Nov. to April.
Bismarck	K.	Oct. to Jan.
Domino	K.	Sept. and Oct.
Golden Spire	K.	Oct. to Dec.
Liddel's Seedling	K.	Sept. and Oct.
Bramley's Seedling	K.	Jan. to April.
Early Victoria	K.	July and Aug.
Lord Grosvenor	K.	Aug. and Sept.
The Queen	K.D.	Oct. to Dec.
Cox's Pomona	D.K.	Oct. to Dec.
Mr. Gladstone	D.	August.
Beauty of Bath	D.	August.
King of the Pippins	D.	Oct. to Jan.
Worcester Pearmain	D.	Sept. and Oct.
Lady Henniker	K.D.	Dec. to Mar.

D.=dessert, K.=kitchen fruit, D.K.=both purposes. Months give usual time of perfection.

The well-known varieties that have proved least satisfactory are:—Potts' Seedling, Ecklinville Seedling, Red Astrachan, Stirling Castle, Warner's King, Cellini, Baumann's Red Reinette, Cox's Orange Pippin, Newton Wonder, Allington Pippin, and Duchess of Oldenburgh.

Stocks.—Tests with regard to stocks on which to graft the different varieties, indicate the accuracy of the accepted principle that for half-standards and standards the crab and free stocks are essential, while for bush and pyramid trees the broad-leaved English paradise stock is usually best. Exceptions are Stirling Castle, Lane's Prince Albert, Bismarck, Golden Spire, and the weaker growing dessert varieties. These varieties would be better on the free stock.

Pears and Plums.—Pears, of which several varieties were planted, although in several instances they set well, failed to develop fruit of good size and quality. Excepting for the variety Victoria, plums have not proved a success on the cold soil of the fruit plot proper. A further planting was made in 1921 on the warmer soil of the Upper Nursery, with maiden trees from Malling, as follows:—3 each of Victoria, Belle Louvain, and Giant Prune, all on the St. Julien plum stock; 3 Pershore plums on own roots, and 3 Purple Pershore plums on the Brompton plum stock.

Flowering of Apples and Resultant Crop.—Observations, tabulated below, show that the latter half of May and the first week in June has been the general flowering period for the past eight years. This relatively late period is undoubtedly a favourable factor in apple production at this station, securing, as it does, considerable immunity to the late spring frosts which often operate so seriously in the valleys. It must be recorded that whilst fair and warm weather at flowering time is favourable to a good crop, the latter is mainly dependent on the building up of abundant fruit buds during the preceding year, this in itself being an effect of good management.

Year.	Main Flowering Period.	General Weather.	Crop in Cwts.
1913	May 21—June 7	Fair, warm, dry	10
1914	,, 8—May 25	Changeable; mostly fine and warm	$20\frac{3}{4}$
1915	,, 22—June 9	Winds mainly W.; fair and warm	$20\frac{1}{2}$
1916	,, 19— ,, 5	Very changeable; moderate temp.	$9\frac{5}{8}$
1917	,, 29— ,, 11	Winds variable; mainly fine and warm	$5\frac{5}{8}$
1918	,, 15—May 29	Winds S.W.; very fine and warm	$32\frac{1}{8}$
1919	,, 20—June 4	Winds E.; hot days, cool nights, very dry	$18\frac{3}{4}$
1920	,, 12—May 28	Winds variable; even temp., fair	$16\frac{1}{4}$
1921	,, 6— ,, 23	Winds mainly W.; variable temp., dry	15

Black Currants grow strongly and fruit well Victoria and Carter's Champion have proved good varieties. Boskoop Giant has proved a splendid variety, and has the additional merit of ripening a fortnight earlier than Victoria. The Seabrook, which exhibits relative immunity to big bud mite, also does well, ripening slightly later than Boskoop.

Red Currants give good results, but are not planted largely, as they are not the most popular of soft fruits. Good varieties are Comet (Versailles) and Raby Castle (Houghton Castle).

Gooseberries fruit well, Whinham's Industry being mainly planted.

Raspberries crop well, but deteriorate if not well manured, this being especially so with Superlative, otherwise one of the best varieties. Wisbech Perfection grows much too rankly. Recently planted sorts showing promise are The Devon, Hexham Rough Cane and Penwill's Champion.

Rhubarb.—A collection of 10 varieties of this important vegetable "fruit" has now been established. Royal Albert (syn. Prince Albert and Early Albert) is the earliest to begin to grow, closely followed by Challenge (Dawes), Victoria, Hawke's Champagne and The Sutton—a group of varieties with rich red stalks and plenty of vigour.

Strawberries.—Observation over the last six years demonstrates the unsuitability of very late kinds for the north-east. Of the best early kinds grown here, The Duke compares favourably with, and resists mildew better than, either Royal Sovereign or King George. Though somewhat soft in the berry for marketing, all three are good earlies. Among the firmer fruited second earlies, Paxton did badly; Utility and Rival well; Givons Late Prolific, McMahon, and Maincrop fairly well.

THE WEATHER OF 1921.

The average rainfall at Cockle Park for the past 24 years was 27·02 inches. In 1921 the rainfall was 25·44 inches. August was the wettest month (6·38 inches) and February was the driest month (·25 inches). The average amount of sunshine in the past 24 years was 1,417 hours. In 1921 there were 1,500 hours of sunshine, May having the most sunshine (241 hours) and January the least (35 hours).

A register of the summer frosts on the grass at Cockle Park from May 15th till September 30th, has been kept since 1894. The results from 1894 till 1914 are given in the Cockle Park Guide for 1915, and show how subject the north-east of England is to these frosts.

The following are the records for 1921, given in degrees Fahrenheit (30° F = 2° of frost, being 2° under freezing point, 32° F.):—May 16th, 2°; 18th, 3°; 19th, 1°; 21st, 4°; 23rd, 2°; 27th, 6°; 28th, 6°; 29th, 1°; June 2nd, 2°; 6th, 5°; 7th, 1°; July 2nd, 1°; 5th, 6°; 24th, 4°; 30th, 5°; August 26th, 2°; 30th, 1°; 31st, 4°; September 24th, 1°; 28th, 4°.

The foregoing are the minimum night temperatures registered on the grass, and not at four feet above the ground, as is usually the case. The former are generally lower than the latter.

Northumberland suffered more severely from summer frosts in 1921 than in any year since 1898. The long drought also from the beginning of February till the end of June did great harm. The total amount of rain in these five months was 4·09 inches, whereas the average for these months was 10·7 inches. The frosty evenings during the summer probably did more harm even than the drought. Swedes had a lower feeding value last season than in any year recorded, the average content of dry matter being down to 10·24%, whereas the average is 12%. The severe frosts in July must have done great harm to corn and all crops at this critical period.

Temperature in cultivated and uncultivated soil, and influence of good cultivation.—At Cockle Park two sets of earth thermometers at depths of 1 foot and 4 feet are kept in adjacent plots of ground, the soil around one set being kept cultivated to a depth of about 2 inches, while that around the other is uncultivated. The distance between the two sets is 7 feet. The observer finds that at 9 a.m. there is very little difference between the readings from the two sets, but the thermometers in the cultivated ground are less susceptible to sudden changes of weather than the others. In other words, the earth is kept at a much more even temperature by cultivation, a fact which is no doubt due to the preservation of moisture in the ground. The effect on the readings at 4 feet is very slight.

Samples of soil, at a depth of six inches, were taken from the two plots in the Weather Station (sandy soil and subsoil). The following results were obtained by Mr. Collins:—

Year.	Percentage of Water. Untilled Plot.	Percentage of Water. Tilled Plot.
1908	8·84	11·07
1911	9·53	13·01
1919*	7·67	20·72
1921	11·40	12·66
Average for 4 years	**9·38**	**14·37**

* Until further trials are made this result should be regarded as abnormal.

The samples of soil were taken after periods of dry weather. The tests show how effectually good surface tillage conserves the water in the soil in times of drought.

Crops and their water supply in the summer of 1919.—See Guide, 1921.

RAINFALL AND BRIGHT SUNSHINE AT COCKLE PARK.

Rainfall (in inches).

Year.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1919.	3·33	2·20	2·25	1·28	0·65	0·49	1·33	1·98	1·30	4·27	3·91	2·99	25·98
1920.	2·70	1·25	2·74	3·17	3·60	0·60	3·74	1·95	1·74	1·77	1·13	4·45	28·84
1921.	4·47	0·25	0·82	0·79	1·90	0·33	1·96	6·38	1·55	2·95	2·66	1·38	25·44

Sunshine (in hours).

Year.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1919.	35	54	105	124	194	146	129	180	142	101	61	37	1,308
1920.	54	86	98	106	190	212	122	130	122	69	54	33	1,276
1921.	35	36	100	198	241	213	166	120	164	125	69	51	1,518

For records of the years 1898–1918 see Guide for 1921.

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